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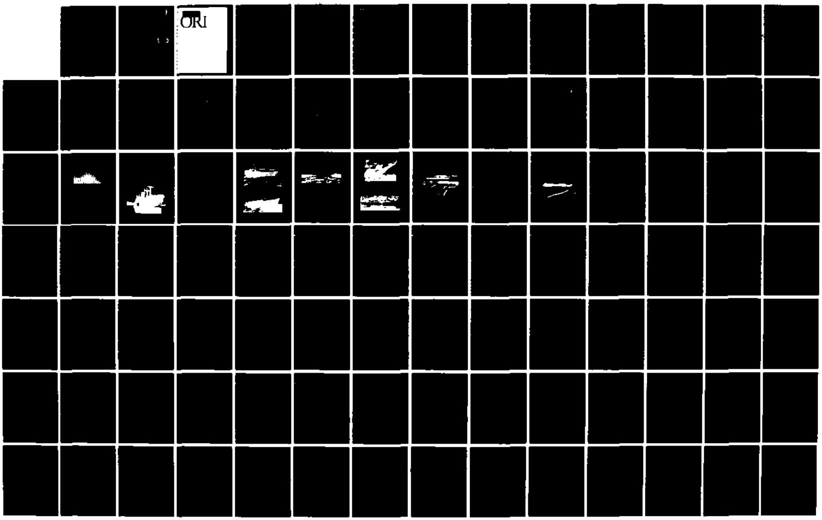

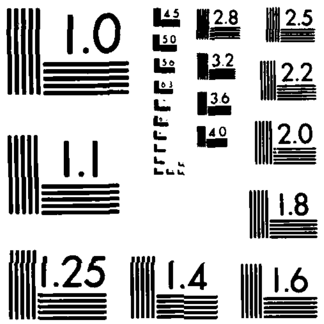

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OPERATIONS RESEARCH, Inc.

SILVER SPRING, MARYLAND

FEASIBILITY AND DEFINITION OF A JOINT LOGISTICS-OVER-THE-SHORE (LOTS) OPERATIONAL TEST

30 April 1975

Prepared under Contract Number MDA-903-75-C-0016
for Office Secretary of Defense,
Director, Defense Research & Engineering (SSST&E)
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RESEARCH AND ENGINEERING

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Walter B. Moore Jr.

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Lieutenant Colonel, USA
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Tactical Air and Land
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I. INTRODUCTION

GENERAL

During calendar year 1973, the Director of Defense Research & Engineering (DDR&E) solicited nominations of projects suitable for joint test and evaluation in the FY 1975 - 1977 time period. One of the areas nominated by the Army and selected for consideration was that of Logistics-Over-The-Shore (LOTS) operations, a subject of great interest and concern to the services, particularly since the advent of containerized ocean shipping systems. In July 1974, the Office of the Deputy Director, Defense Research & Engineering (Test & Evaluation) contracted with Operations Research, Inc. (ORI) to perform the LOTS test definition task.

PURPOSE AND OBJECTIVES

The overall purpose of this study is to define a joint test, or series of tests, concerning the ability of the services to conduct LOTS operations, and the means to accomplish such test(s).

The basic test objectives set forth by the study sponsor are to provide meaningful information that can be used by the services to:

- Alter or confirm:
  - Operational techniques
  - Planning factors
  - Established equipment requirements
- Determine the best force structure for most efficient use of manpower.

SCOPE

Other relevant guidance provided by the study sponsor which shaped the test definition included the following:

- Tests would include a containership and breakbulk ship, with consideration also given to the inclusion of a bargeship and roll-on/roll-off ship.
- Major areas of evaluation would include the quantitative exploration of:
  - LOTS systems deployment techniques
  - Ship discharge procedure
  - Ship-to-shore lighterage functions
  - Beach organization/preparation
  - Overall management and control aspects
- That the tests would be undertaken in the Fiscal Year 1976-77 time period.

METHODOLOGY AND STUDY APPROACH

General

The study team utilized the concept and sequence of the general tasking outlined in the DDR&E directive as the framework for its technical approach to project accomplishment. The tasks were:

1- Review of service experience with LOTS operations and tests to determine the areas accessible to clarification through joint testing.

2- Evaluation of most likely scenarios which might involve LOTS operations, and the development of realistic test scenario(s).

3- Determination of the availability of essential equipment and facilities for conduct of a joint LOTS test.

4- Design of a joint LOTS test or tests to be conducted during FY 1976-1977.

5- Identification of any essential equipment or procedural preliminary test to be carried out before major joint test conditions are fixed.

A list of the activities contacted during the course of the study is contained in Appendix I.

II. SUMMARY

BACKGROUND

Policies and Trends

The challenge of supporting deployed military forces by sealift in areas where fixed port facilities do not exist or are temporarily denied is not a new problem, but its dimensions have been markedly altered in the last decade.

Three key features underlie the increased significance of Logistics-Over-The-Shore or "LOTS" operations.

- The problem is initially shaped by a long-standing Defense Department policy to rely primarily on commercial transportation resources and services in both peacetime and wartime. As rising costs erode an already austere military-controlled fleet, an increasingly large part of our contingency sealift requirements must be met with ships designed to maximize economic return in commercial trade, rather than their utility for military distribution needs.

- The second feature of the LOTS challenge is a result of a major transformation in the configuration of trans-ocean cargo and the ship systems to carry it. In less than two decades the U. S. flag dry cargo fleet has changed from a conventional breakbulk configuration, with its self-loading and discharging capability, to one that is increasingly characterized by large, fast containerships, which require sophisticated fixed terminal facilities for transfer of cargo units that weigh upwards of 30 tons each. Breakbulk ships, once the backbone of contingency sealift planning are disappearing from the seas.

- The LOTS challenge is rounded out by another major defense policy objective. In order to exploit the increased productivity and other benefits of containerization, the DOD is fully committed, as a matter of priority, to the development of military container-oriented logistics systems.

The implications for effectively coping with such logistics systems over-the-shore or in a marginal port environment are readily apparent. LOTS has never been a preferred method of conducting ocean terminal operations. It is expensive -- in terms of time, manpower, and equipment required. Unfortunately, its implementation is usually not a matter of choice. If U. S. forces are to be logistically sustained, some contingency capability must exist for over-the-shore support. Otherwise, the U. S. must restrict its choices for undertaking military operations only to areas where modern container handling facilities exist and also must assume that such facilities will not be denied -- even temporarily -- by military, political, or economic action.

Service Interests and Roles

LOTS operations involve multi-service interests and responsibilities. Both are associated with inherent departmental responsibilities for logistics support as well as assigned service roles and missions. More specific areas include:

- The Army's responsibility for common user ocean terminal operations at fixed facilities or over beaches.
- The Marine Corps' mission interest in LOTS-type operations in follow-on phases of amphibious operations, for which it is responsible.
- The Navy's responsibility for all sealift.

As a result of this broad based interest, all three of these services have individual and collective on-going efforts in LOTS planning, equipment, organization, and doctrinal development.

Adequacy of Current Data

Particularly relevant to this test definition are the limited joint exercises of Offshore Discharge of Containerships (OSDOC) I and II which were conducted in 1970 and 1972. Both exercises were essentially development oriented and did not constitute operational tests of service capability. OSDOC II did provide some useful insights which have guided hardware and doctrinal developments. Because interactions of systems components were not measured, the data on system capability is acknowledged to be inconclusive.

Both old and new combinations of service LOTS organizations and hardware will be available for testing in the prescribed FY 1976-77 time frame.

While not optimally structured, they will constitute, for test purposes, a realistic, in-being service capability. Based on the inadequacies of existing system performance data, and the timeliness of evaluating the newer system elements, joint operational testing is desirable for the purpose of validating capabilities and associated planning factors.

MEASURES OF EFFECTIVENESS

The ultimate measure of LOTS operational effectiveness is the ability of the system to provide adequate and timely support to deployed combat forces. While it is improbable that such an overall measure could be quantified directly, the nearest relevant quantification is the cargo throughput capability of the LOTS system, normally expressed in containers or tons per hour or day. Thus, time, precisely recorded, and related to each cargo module at each link and node of its movement, will be a major measure throughout the test.

System throughput is not a complete measure of effectiveness and must be supplemented with some broader logistics measurements. For example, the suitability of available ships and the time required to deploy LOTS equipment to the objective area are major considerations, as is the ability to accurately identify and distribute cargo after it is discharged by the system and landed ashore. Principal measures of effectiveness for these test areas will be deployment response time and the probability of success in performing essential functions of cargo identification, supplemented by time records for accomplishment of major events.

To address the force structure and manpower test objectives set forth in the study tasking, measurements of time will be supplemented with detailed records of manpower resources, including related supervisory and support personnel requirements. Because resource constraints will limit the physical size and duration of the tests, overall force structure evaluations will be made from extrapolation of the manpower data collected and their application to total scenario requirements.

Some examples of key planning factors and capabilities to be evaluated, and some potential composite measures to be derived are shown in Figures 16 and C.1. In addition, an outline of the measures of effectiveness for the main test, data to be collected, and methods of collection, together with their relationship to test objectives, are shown in Figure C.2.

TEST APPROACH

General

While there are some variations in specific service requirements for Logistics-Over-The-Shore capabilities, the fundamental system elements that are technically feasible during the test period include:[1/]

- Ships capable of deploying LOTS components
- Crane subsystems for ship off-load
- Craft subsystems to move cargo ashore
- Crane subsystems to discharge craft
- Cargo staging and clearance subsystems
- Management and control subsystems.

Within these subsystems a variety of equipment options are available to meet specific operational and environmental requirements. The proposed approach for the joint LOTS test design is the selection of a system which, for test purposes, is as representative as possible of the fundamental elements, and which will also address the most common multi-service requirements. An array of system options available and those recommended for testing are shown on the following page. Operational testing of the options selected will provide a maximum of quantitative data applicable to a variety of alternative options or their mixes. Such an approach can accomplish the test objectives with a prudent expenditure of resources.

Operational and Environmental Conditions

Strategic/Tactical Scenario. The proposed test approach utilizes two basic operational settings which span the most likely contingency situations for LOTS operations. One is a non-mobilization scenario where sealift assets are constrained, as is the scope and duration of military operations. The second is a mobilization contingency to permit a more complete range of ship availability, operating conditions, and testing of other appropriate system options.

1/ Not all type ships to be discharged would require all systems elements, e.g., self-sustaining ships, or roll-on/roll-off ships.

TYPE SHIP INTERFACE REQUIREMENT / LOTS CARGO DISCHARGE OPTIONS	SHIP OFFLOAD: CRANE ON DECK (A)	CRANE ON BARGE (A)	1/ MODIFIED CRANE ON DECK (N)	1/ CRANE ON FLOATING PLATFORM (TCDF) (N)	ORGANIC SHIPS GEAR –	HELI-COPTER (A-N)	LIGHTERAGE: LAND CRAFT (A-N)	AMPHIB (A)	CAUSEWAY FERRY/TUG (N)	BARGE W/TUG (A-N)	ACV LIGHTER (A)	SHORESIDE DISCHARGE & BEACH HANDLING: BEACH CRANE (A)	CRANE ON ELEV CAUSEWAY (N)	CARGO DISTRIBUTION MANAGEMENT: MANUAL (A-MC)	ADP (TOMMS) (A)
I NON-SELF SUSTAINING CONTAINER SHIP															
• DEPLOYMENT	✓	NA	✓	NA	NA	✓	✓	✓	NA	NA	✓	NA	NA		
• DISCHARGE	✓	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓	✓		
• DISTRIBUTION						NOT APPLICABLE								✓	✓
II BREAKBULK SHIP															
• DEPLOYMENT	NA	✓	NA	NA	NA	NA	✓	✓	NA	NA	NA	✓	NA		
• DISCHARGE	NA	NA	NA	NA	✓	✓	✓	✓	✓	✓	✓	✓	✓		
• DISTRIBUTION						NOT APPLICABLE								✓	✓
III BARGESHIP															
• DEPLOYMENT	NA	✓	NA	NA	NA	✓	✓	NA	✓	✓	NA	✓	✓		
• DISCHARGE	NA	NA	NA	NA	✓	✓	NA	NA	NA	✓ 2/	NA	NA	✓		
• DISTRIBUTION						NOT APPLICABLE								✓	✓
IV ROLL-ON ROLL-OFF SHIP															
• DEPLOYMENT	(ALTERNATE FOR CONTAINERSHIP OR BARGESHIP)														
• DISCHARGE	NA	NA	NA	NA	NA	NA	✓	NA	✓	✓	NA	NA	NA		
• DISTRIBUTION						NOT APPLICABLE								✓	✓

OPTION LEGEND:

✓ SYSTEM OPTION

✓ PRIORITY OPTION FOR TESTING

✓ LIMITED TEST ONLY

NA NOT APPLICABLE

NOTES:

1/ PRIORITY FOR TESTING OVER ARMY TERMINAL UNIT CRANES IF AVAILABLE IN FY 77

2/ ORGANIC SHIPS BARGE

MAJOR LOTS SYSTEM OPTIONS FOR JOINT TEST

Operational Parameters. Variables such as ship-to-shore distances and cargo inland destination distances may be major determinants of the operational suitability of some LOTS subsystems. However, cost and administrative constraints limit the number of physical test sites which would otherwise be required to provide a range of these variables. Frequent repositioning of ships or facilities would involve significant time losses and disruptions. To determine the effects of changes in these and other variables on various system capabilities, simulation of LOTS systems is proposed as an augmentation to field tests.

Weather and Sea Conditions. While susceptible to quantitative measurement, weather and sea state are largely beyond the control of the test program. The proposed approach for the main test, subject to other scheduling constraints, is the selection of a period affording a reasonable probability of generally favorable conditions with some likelihood of more demanding sea states. An analysis of wave data at the proposed test site indicates that while there is a strong likelihood of conditions which will slow or possibly interrupt operations, their persistence is relatively brief. Comprehensive weather and sea condition measurements will be made and their effects on LOTS system productivity calculated.

Main Test Concept

The proposed test definition involves a dedicated LOTS operational test off Ft. Story, Virginia, in the second half of FY 1977. The test comprises three main areas of functional evaluation:

- Area I LOTS System Equipment Deployment Capability
- Area II Cargo Discharge Capability
- Area III Cargo Distribution Interface Capability

In general, the test is designed to evaluate, under conditions of both a mobilization and non-mobilization scenario, the capability to: deploy LOTS equipment to an unimproved operational area using commercial type ships; establish a discharge system; conduct sustained cargo off-loading under realistic operating conditions with service organizations and equipment; and manage the handling and distribution of cargo ashore. A schematic of an illustrative test schedule of events is shown on the following page. The duration of the operation (system performance replications) represents a compromise that takes into account the accuracy of measurements desired, minimum operational requirements, and the high cost of ship charters. A more detailed explanation is in Appendix E.

TEST DAY	T DAY	T +1	T +2	T +3	T +4	T +5	T +6	T +7	T +8	T +9	T +10	T +11	T +12	T +13	T +14	T +15
NON-MOB SCENARIO DAY			D + 11	D + 12	D + 13	D + 27	D + 28	D + 29	D + 30	D + 31	D + 32					
SHIPS																
							LCM AMPHIB	LCM AMPHIB	LCM AMPHIB							
BREAKBULK (HVY LIFT)	LOAD 300 S/T EXERCISE CARGO	LOAD 300 S/T EXERCISE CARGO	LOAD BEACH CRANE & LCU (2) LARC LX	SAIL TO TEST SITE PREP. TO OFF LOAD	OFF-LOAD LCU & BEACH CRANE	BEACH PREP & ORGANI-ZATION	DISCH 150 S/T EXERCISE CARGO	DISCH 300 S/T EXERCISE CARGO	DISCH 150 S/T EXERCISE CARGO (SAIL)							
								CRANE-ON-DECK				CRANE-ON-BARGE (TCDF)				
								ACV LCU	ACV LCU HELO	ACV LCU	ACV LCU HELO	ACV CW FERRY	ACV CW FERRY LCU	ACV CW FERRY		
NON-SELF SUSTAINING CONTAINER SHIP			LOAD TEST CONTAINERS & CRANE-ON-DECK		LOAD LACV & LIGHTERS	SAIL TO TEST SITE PREPARE TO OFF-LOAD CRAFT	OFF-LOAD LOTS SYSTEM CRAFT	DISCH 150 CONT.	DISCH 300 CONT.	DISCH 150 CONT. RETRO 150	RETRO 300	DISCH 150 CONT. RETRO 150	DISCH 300 CONT.	DISCH 150 CONT. (SAIL)	OFF-LOAD CRANE POST EXERCISE INSPECT	
MOBILIZATION SCENARIO DAY							D + 40	D + 41	D + 42	D + 43	D + 44	D + 57	D + 58	D + 59	D + 60	D + 61
											LCU	TUG	TUG			
BARGESHIP								LOAD CAUSEWAY & CRANE/BARGE & NSDA (OPTION)		SAIL TO TEST SITE PREPARE FOR OFF-LOAD	OFF-LOAD CAUSEWAY & CRANE/BARGE	DISCH SHIPS BARGE FLY-AWAY ACFT	DISCH SHIPS BARGE RECOVER BARGES	(SAIL) POST EXERCISE INSP		
ROLL-ON ROLL-OFF SHIP												LOAD VEHICLES & EQUIP (EX CARGO)	SAIL TO TEST SITE PREP TO OFF-LOAD	OFF-LOAD TO LCU	OFF-LOAD TO CW FERRY	
CARGO DISTRIBUTION							CRANE ON BEACH					CRANE ON ELEVATED CAUSEWAY				
BEACH MARSHALLING SITE						AREA PREP & ORGANI-ZATION	RECEIVE 150 S/T	RECEIVE 300 S/T 150 C	RECEIVE 150 S/T 300 C	RECEIVE 150 C 50 CR RETRO 150	RECEIVE 50 CR RETRO 300 C	RECEIVE 150 DD 50 TRANS 50 RETRO 150	RECEIVE 300 C DD 50 TRANS 50	RECEIVE 150 C DD 50 TRANS 50		
INLAND SUPPLY FACILITY								REC 50 S/T	REC 100 S/T REC 50 C	REC 50 C RET 50 C		REC 100 C	REC 100 C	REC 100 C		

DEPLOYMENT
CARGO DISCHARGE
DISTRIBUTION

ILLUSTRATIVE MAIN TEST SCHEDULE

The cost of the test program cannot be predicted accurately until more detailed test plans and schedules have been developed. Based on the illustrative main and pre-test concepts, level-of-effort estimates of both the unique joint test costs and additional service support requirements are outlined in Section IV. A more detailed estimate in terms of test task organization, personnel and equipment, and support services is contained in Appendix H.

The level of detail in the illustrative test schedule was required to provide a basis for estimating test resource and support requirements. Its development required certain assumptions as to types and availability of commercial ships. Because bargeships and containerships are not part of the MSC controlled fleet, the detailed test schedule may require modification to accommodate to the availability and configuration of the specific ships that are made available from commercial sources.

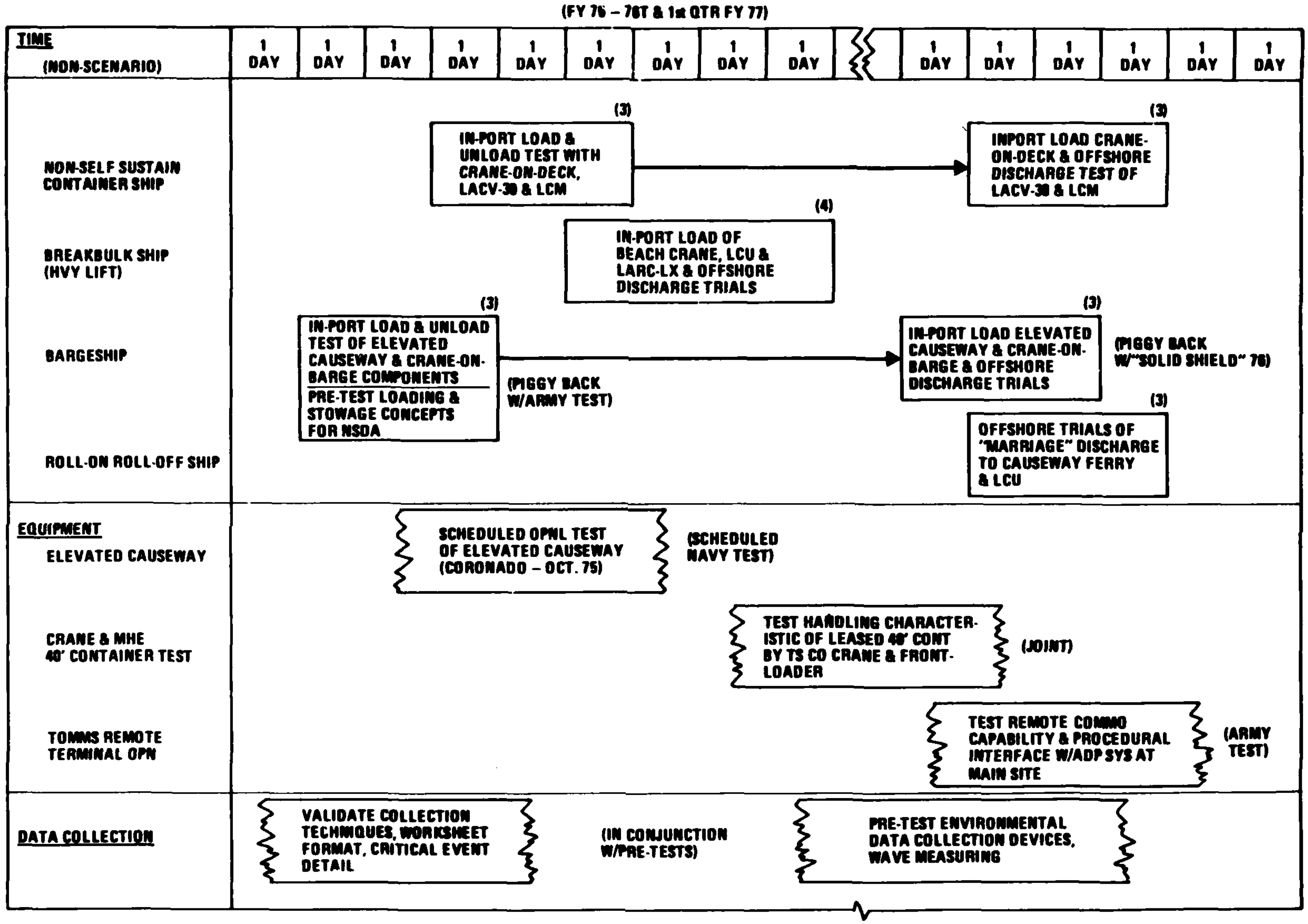
Pre-Tests

The key pre-test requirements identified are shown on page 11 They relate mainly to the LOTS System Deployment Capability area of the main test.

The increased size and weight of cranes, craft, and other LOTS equipment have limited the type and number of ships capable of rapidly deploying and off-loading them at a marginal port or off-shore. A consideration underlying the proposed pre-tests is that several of the theoretically capable ship systems have not been operationally tested in this mode. While the LOTS system deployment concepts proposed for the main test are considered technically feasible, thorough check tests will verify main test event sequencing and scheduling, and minimize the risk of major delays.

The pre-tests consist of selected LOTS system equipment load and off-load evaluations of a non-self sustaining containership, a bargeship, and a breakbulk ship. Their purpose is mainly to insure the most realistic and efficient match of ships and LOTS system equipment to be deployed, and the resolution of any timing or technical problems that may not have been anticipated. The pre-test concept envisions initial in-port load and off-load check tests, followed by second phase pre-tests of system equipment discharge in an off-shore environment. Pre-test results will be used to verify and if necessary, refine the main test deployment schedules.

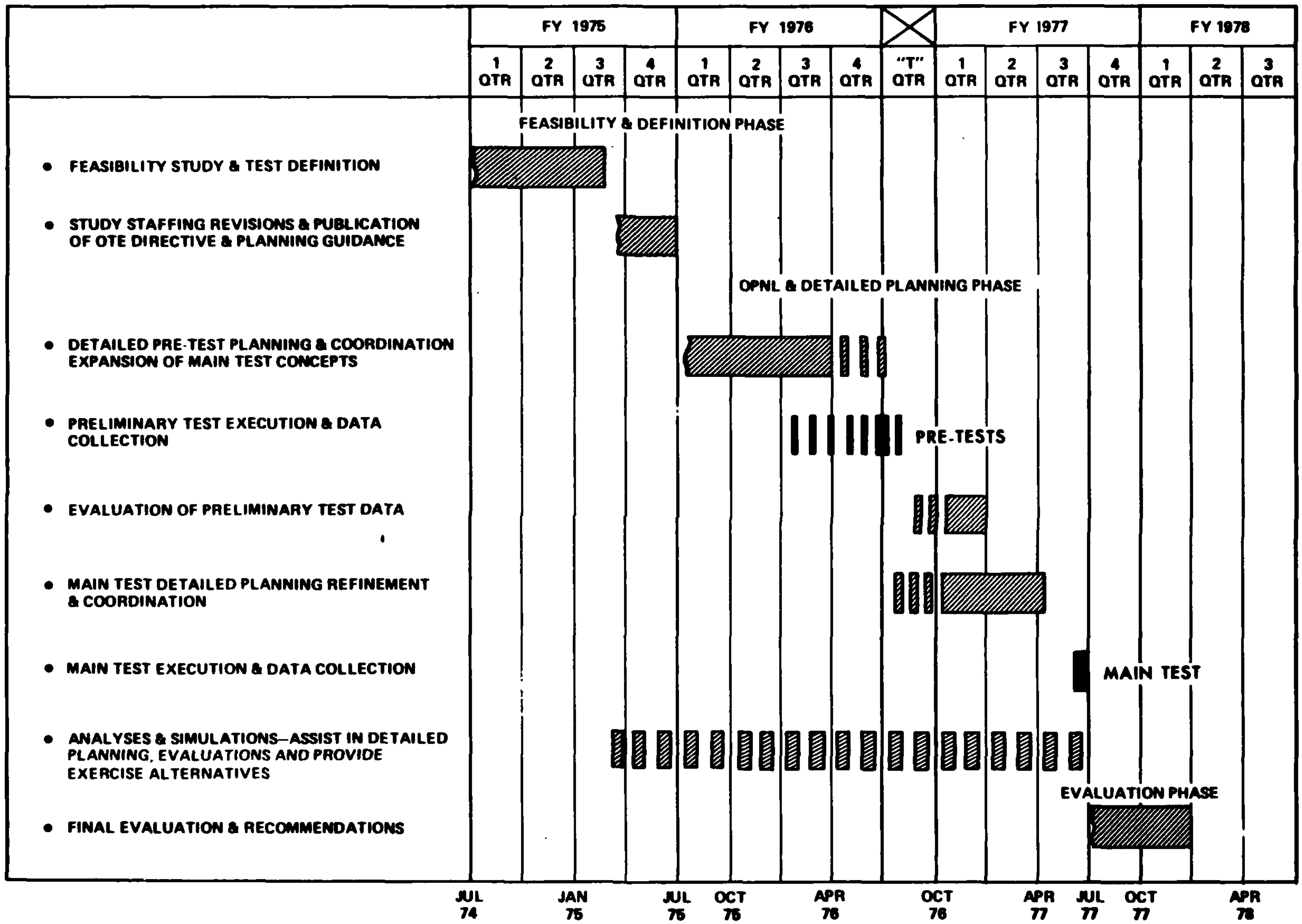
Other joint pre-tests include validation of parameters for the roll-on/roll-off ship "marriage" technique with landing craft, and an equipment handling test of 40-foot containers. Major service pre-tests identified include the operational evaluation of the Navy's Elevated Causeway, and a check test of the remote capability of the Army's Terminal Operations and Movements Management Subsystem - Standard Port System (TOMMS).



LOTS SYSTEM DEPLOYMENT TEST AND OTHER PRE–TESTS

Test Program Phasing

The overall concept and phasing of the LOTS joint test program are outlined in the schematic shown on the following page. The target schedules are general approximations, to be refined as detailed test planning progresses and test equipment availability is confirmed.



LOTS TEST AND EVALUATION PROGRAM PHASING

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III. BACKGROUND

SECTION SUMMARY

Trends

The advances in technology which have produced bigger, faster, and more productive ships have created new dimensions in the age-old problems of providing logistics support in areas where port facilities are inadequate. With the advent of non-self-sustaining ships, increasingly heavy and outsize cargo modules, and the concentration of ship productivity in rapid turn-around capability, the conduct of Logistics-Over-The-Shore operations has moved beyond the reach of traditional expedients.

Policies

To further its policy of reliance on commercial transportation resources and to exploit the potential benefits of containerization, the Defense Department is fully committed to a container supported surface distribution system. The system has the potential for much greater productivity to support military transportation requirements, but in instances where fixed port facilities are inadequate or denied, it also embodies a significant challenge.

Service Roles

LOTS is a multi-service mission area, the highlights of which include:

- The Army's responsibility for common user ocean terminal operations at fixed facilities or over beaches.
- The Marine Corps' mission interest in LOTS-type operations in follow-on phases of amphibious operations, for which it is responsible.

- The Navy's responsibility for all sealift.

Adequacy of Current Data

There is a void in terms of meaningful operational data for the projected near-time frame LOTS capabilities. Previous LOTS evaluations since the advent of containerization have been development-oriented. The two previous joint field tests of Offshore Discharge of Containership (OSDOC) I and II provided some useful insights which have guided hardware and doctrinal developments. But, because they were not conducted under realistic operating conditions and did not measure performance on any systems basis, the data acquired are limited and inconclusive.

Availability of LOTS Elements for Testing

Figure 1 is a projection of the availability of major LOTS system components (organization and equipment) for the period FY 1975 - 1980.

The most significant observations that can be drawn from the availability projections are:

- That in addition to the conventional organizations and equipment used during the OSDOC II tests, new container-LOTS capable units and related hardware will be available for operational testing during FY 76 - 77.
- That these system elements will be representative of the FY 77 - FY 80 service LOTS capability, though not necessarily the optimum system components or at the force levels that may eventually be authorized.
- That significant decisions are due in the next few years, both on service force structuring to provide a LOTS capability and the total quantities of related systems hardware now being procured as pre-production items or limited initial buys of commercial equipment.

Test Timing & Feasibility

Based on (1) the inadequacy of valid data for LOTS systems operational capability estimates, (2) the introduction of new service organizations and subsystems components since the OSDOC evaluations, and (3) the timeliness of the opportunity and need to realistically evaluate the projected near-time frame capability, joint LOTS operational testing is considered both desirable and technically feasible in the prescribed FY 1976 - 1977 time period.

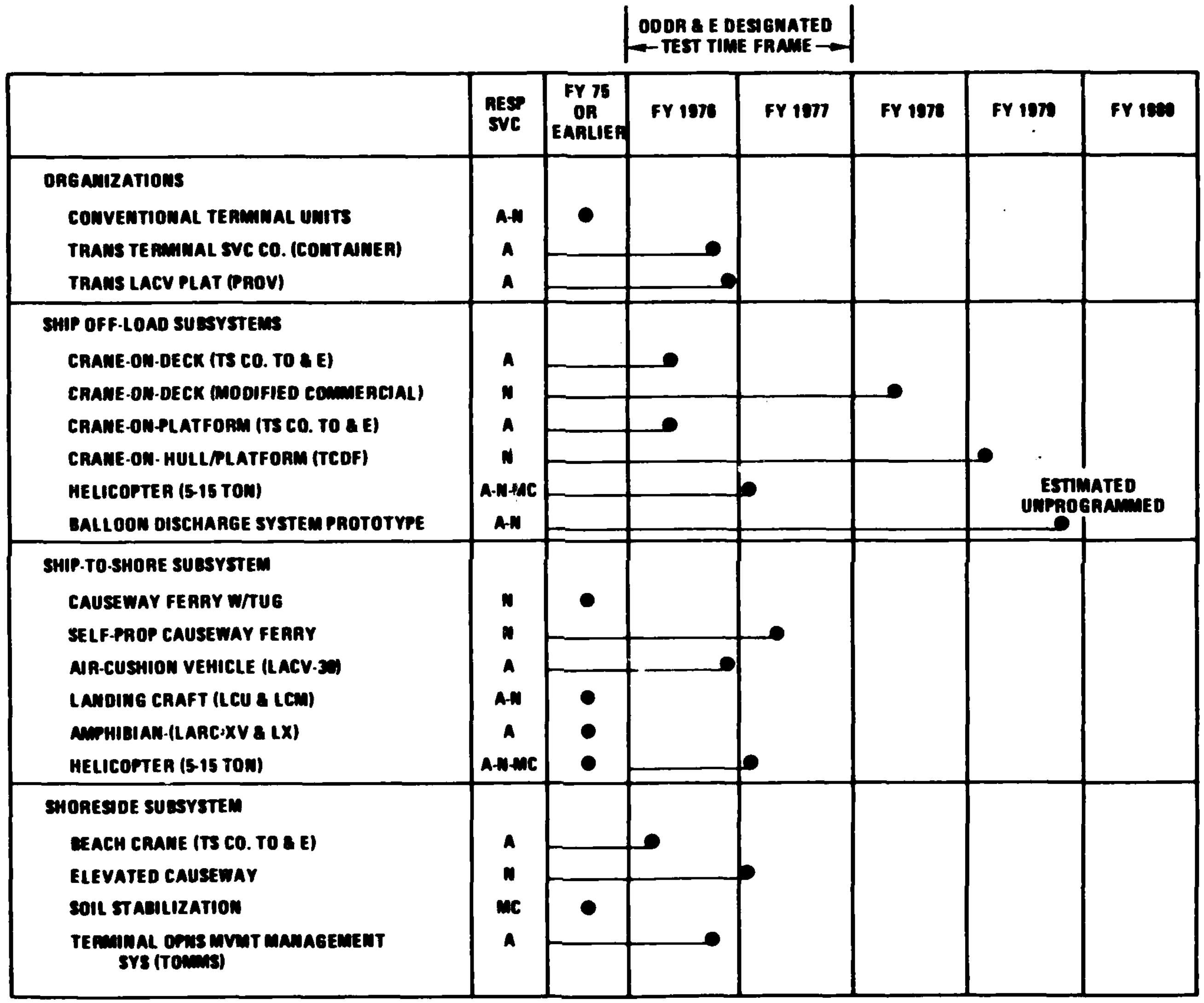

FIGURE 1. PROJECTED AVAILABILITY OF MAJOR LOTS SYSTEM EQUIPMENT AND ORGANIZATIONS

TRENDS

Throughout military history there has been a requirement to land military forces over unprepared beaches and to resupply such forces in the conduct of their campaigns. This requirement has not disappeared in the demands of modern warfare. In fact the advances in technology which have resulted in bigger, faster and more productive means of trans-ocean surface shipping have created new dimensions in the ever-present challenge of conducting Logistics-Over-The-Shore operations. A brief resume of the history of LOTS is contained in Appendix A.

The dimensions of the LOTS problem are initially influenced by a long-standing policy of the Department of Defense to rely primarily on commercial transportation resources and services in both peacetime and wartime, in so far as such support is responsive to military requirements. A variety of economic and other factors have tended to increase the emphasis on the use of commercial transportation capabilities and to reduce military owned or controlled assets to the minimum essential requirements. The decline of the general cargo assets of the Military Sealift Command is reflected in Figure 2 and its current status in Figure 3. The combination of both U. S. owned and controlled (long term charter) ships of this fleet carry only a fraction of the peacetime defense surface cargo and has only a marginal capability to meet the surge requirement of a contingency situation.[1/]

1/ Figures vary depending on precise definition of terms but in general, MSC "contracts out" approximately 80 percent of its defense cargo movement to commercial operators.

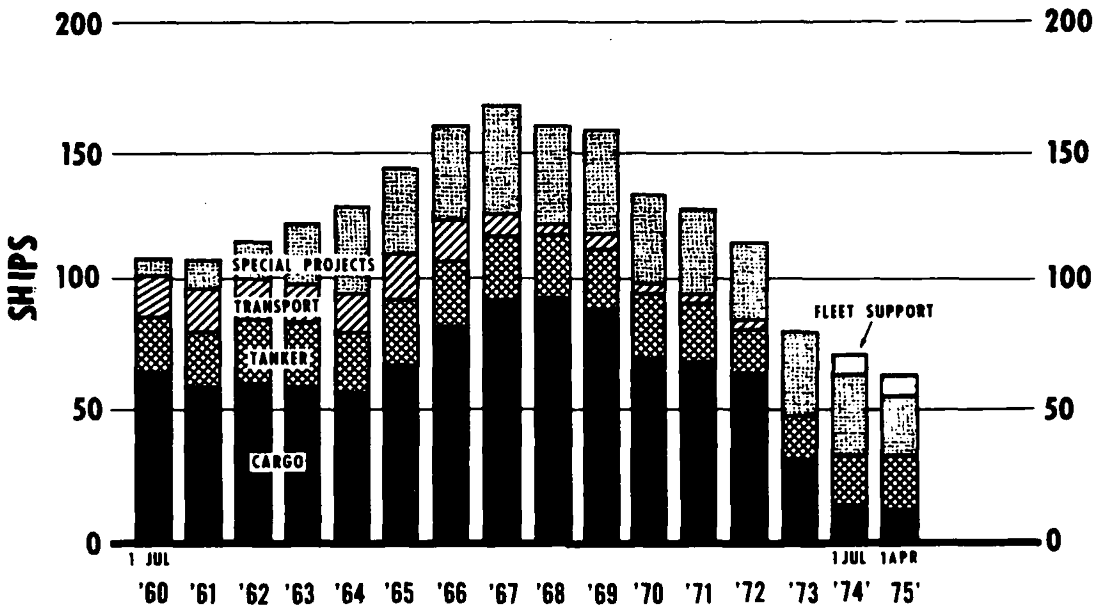

FIGURE 2. MSC NUCLEUS FLEET TRENDS

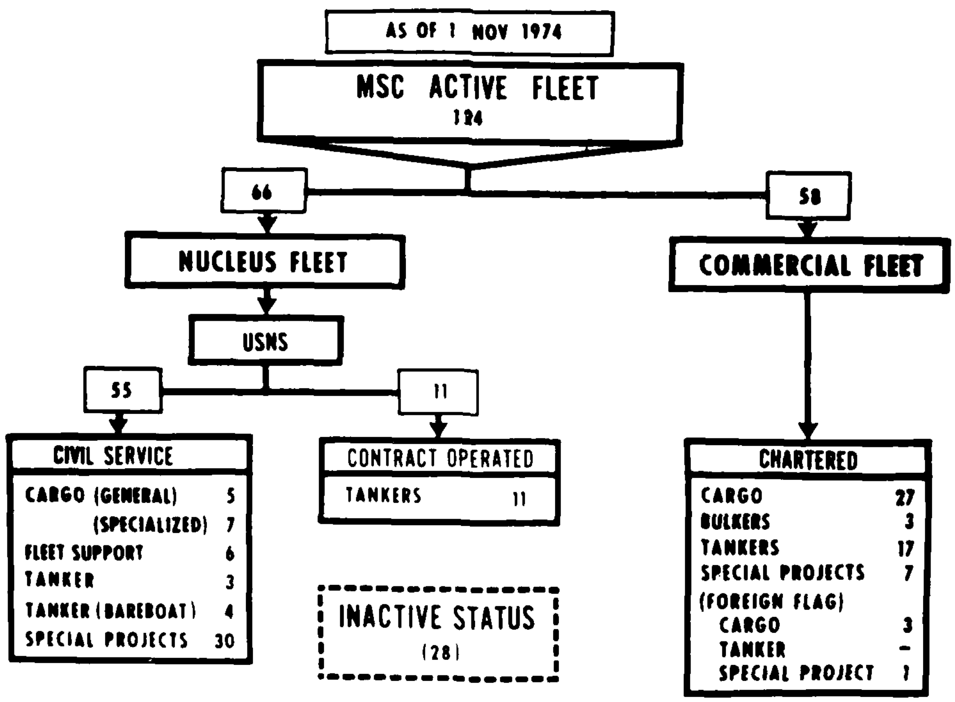

FIGURE 3. MSC ACTIVE FLEET

With an apparently increasing requirement to look outside organic DOD sources for responsive military sealift capability, another facet of the LOTS problem relates to the U. S. flag merchant fleet. Specifically, the major changes that have occurred in the past two decades -- in cargo configuration and the specialized ship systems to move that cargo.

For centuries, the basic cargo handling concept of ocean-going ships remained essentially unchanged. Aptly labelled the "breakbulk" concept, it was a labor intensive approach which generally involved cargo so packaged that it could ultimately be placed on a strong back to reach its final destination -- and frequently was. Figure 4 depicts a typical breakbulk freighter of World War II vintage. Such ships were relatively slow, but were capable of serving virtually every port or anchorage in the world. Their self-contained capability to load and unload cargo made them in a sense, "LOTS capable," with even the most rudimentary type of small craft able to serve as cargo lighters.

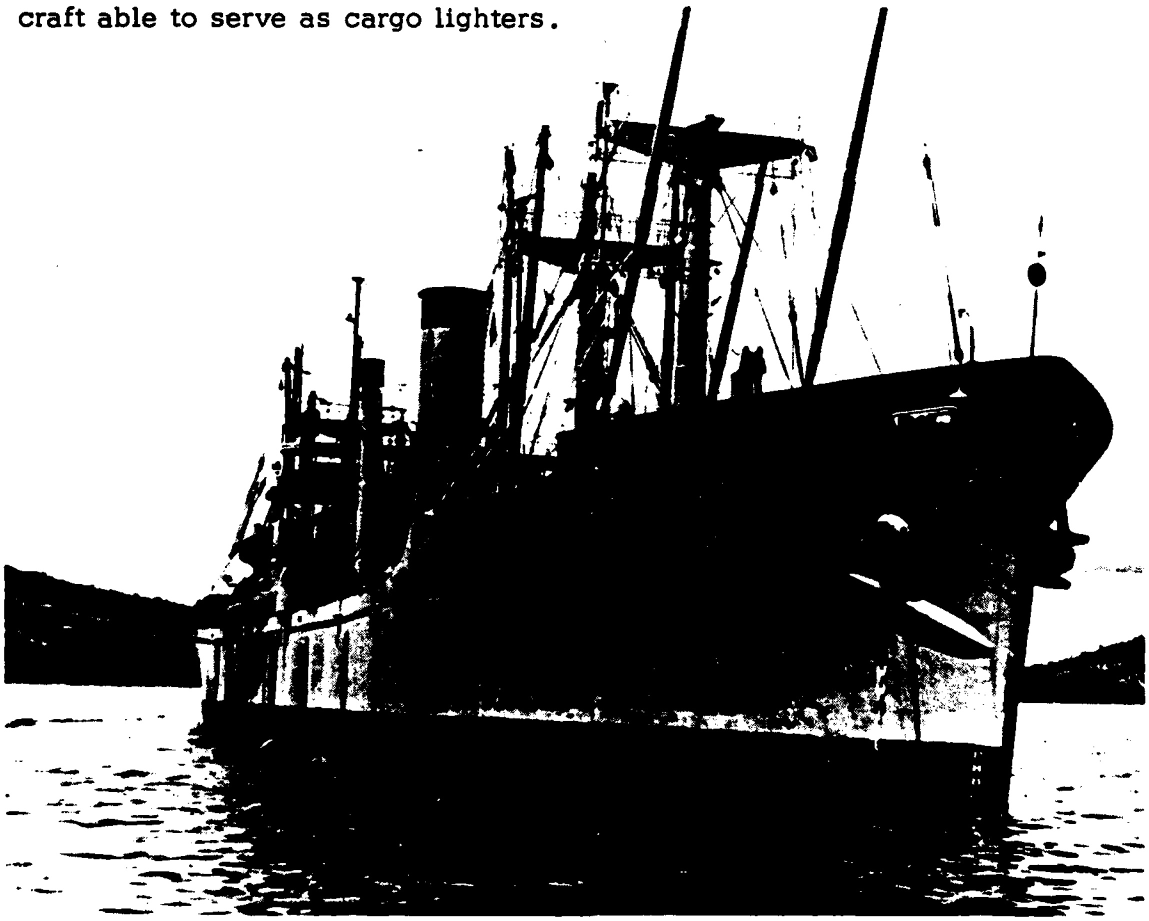

FIGURE 4. BREAKBULK FREIGHTER

Beginning in the early and mid-1950's, major changes in trans-ocean shipping were evident, driven largely by economic factors such as the:

- Rising labor costs of multiple handling
- Need for competitive speed in delivery
- Desire for added security against pilferage and damage.

"Containerization" started to make itself known. Cargo was consolidated in large metal boxes,generally 8' wide, 8' high and in lengths that ranged from 20 - 40 feet. A 20-foot length was initially the most popular. Its loaded weight averaged about 12 - 15 tons for the 20-foot container and upwards of 30 tons for the larger containers.

At first, the ships used for container cargo were improvised. The more modern breakbulk vessels were converted to container-capable ships, by both deck stowage techniques and the installation of container cells (rail-guided frameworks) in conventional ship holds. Significantly, these early modifications usually retained the ship's self-sustaining capability, whether in conventional winch and boom configuration or by the installation of larger, traveling gantry cranes such as that shown in Figure 5 .

This was, however, a transition period . As containerization was proving itself through increased productivity, ship design evolved to further maximize load-capacity and quick turn-around, which further minimized operating costs. One primary means of accomplishing this was elimination of the self-sustaining capability of the containership. Figure 6 depicts a modern non-self-sustaining containership capable of moving over a thousand containers at over 30 knots. Virtually all the containerships constructed during the last 10 years are the non-self-sustaining type.

The economics of the new system required investing in cranes for ocean terminals rather than on ships and the necessity for large facilities and special handling equipment at origin and destination. Figure 7 depicts a typical modern container terminal facility. This "fixed base approach" also means that containerships are usually engaged in dedicated, point-to-point service, and serve mainly the high density trade routes.

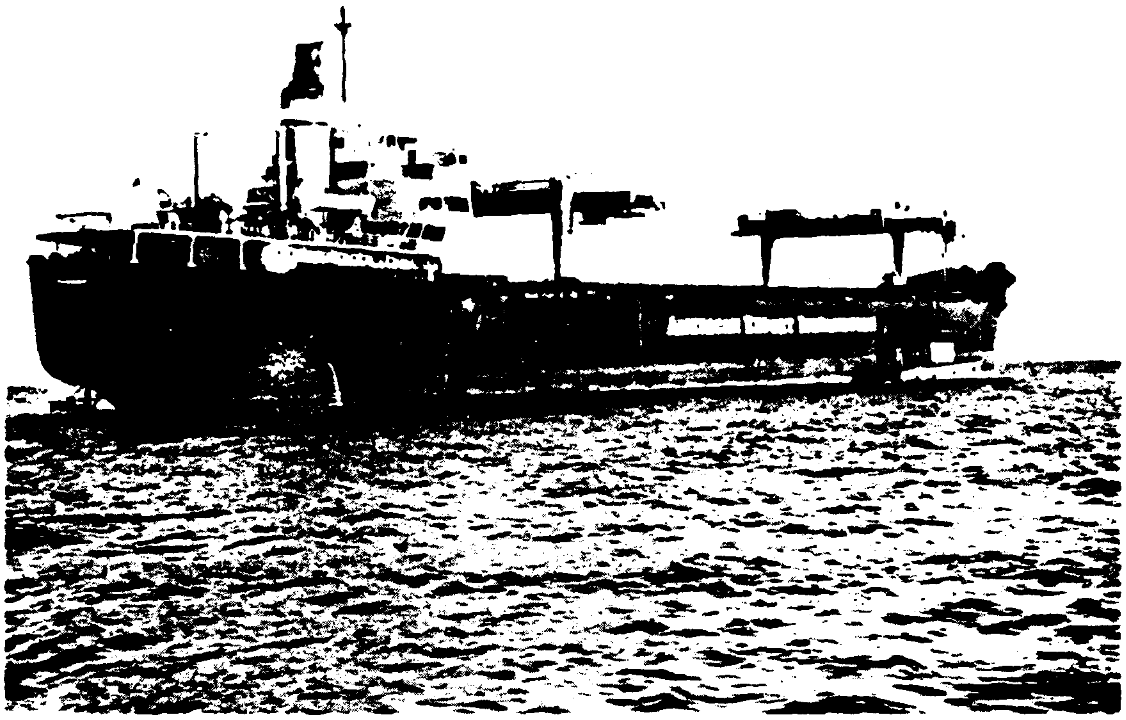

FIGURE 5. CONTAINERSHIP CONVERSION

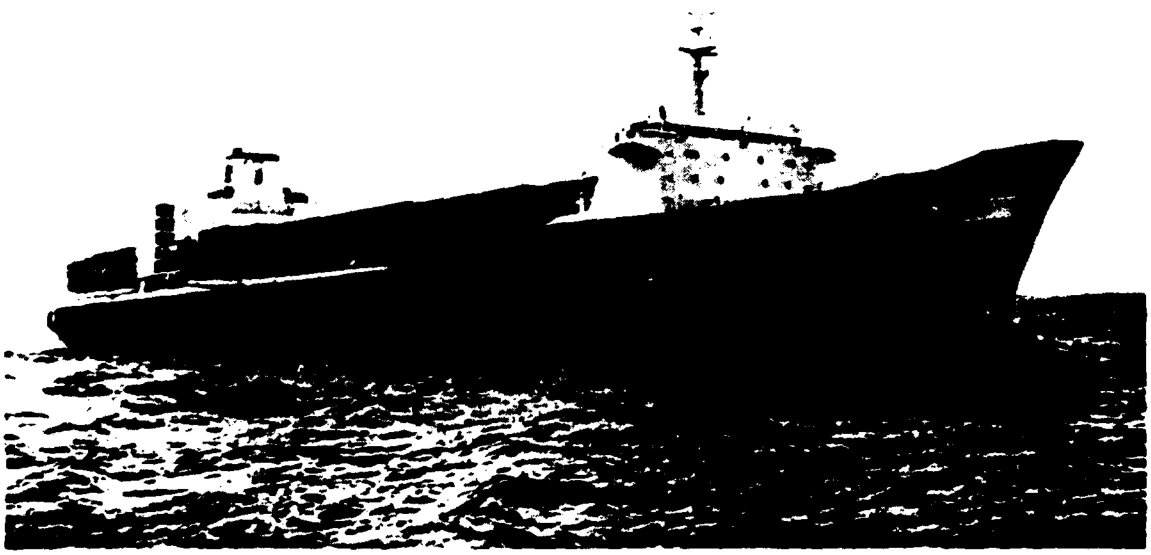

FIGURE 6. MODERN NON-SELF-SUSTAINING CONTAINERSHIP

FIGURE 7. CONTAINER TERMINAL FACILITY

The implications for using such transportation assets over-the-shore or in an unimproved port environment are readily apparent. LOTS has never been a desirable method of conducting ocean terminal operations. It is expensive in time, manpower, and equipment. But because of these relatively recent developments, i.e., non-self-sustaining ships, heavy outsized lifts, and concentration of ship productivity in rapid turnaround, the conduct of LOTS has moved beyond the reach of expedients which traditionally involve adding manpower, and beyond the capacity of many of the conventional mechanical handling devices.

There are some other related developments in ocean shipping which also impact on LOTS -- the advent of bargeships and roll-on/roll-off ships. Both are more specialized in their functions than containerships and were constructed in lesser quantities. Figure 8 depicts the Seabarge ship or "SEABEE." There are only three such ships in the U. S. flag fleet and none are under construction. The SEABEE carries large river-type barges of about 900-ton capacity each which are self-loaded and unloaded by a huge stern elevator. A horizontal conveyor system is used for positioning cargo aboard the ship.

A second type bargeship is the Lighter-Aboard-Ship or "LASH" shown in Figure 9. It is somewhat smaller than the SEABEE and has similar capabilities. There are currently 20 LASH ships in the U. S. Merchant Fleet. It employs a gantry crane system and a vertical loading technique for barge and cargo handling.

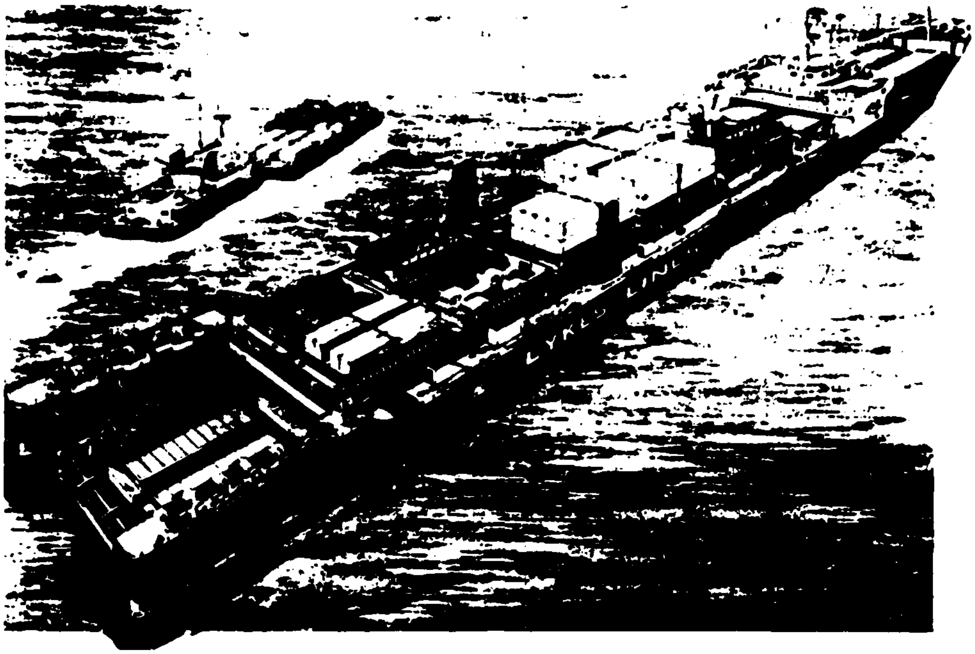

FIGURE 8. SEABEE

Both SEABEE and LASH ships have exceptional military potential in their capability to deliver large quantities of cargo using their barges via inland waterways to points otherwise inaccessible to deep draft ships. Also, both have unique deck and below-deck space for transporting outsize and heavy military equipment.

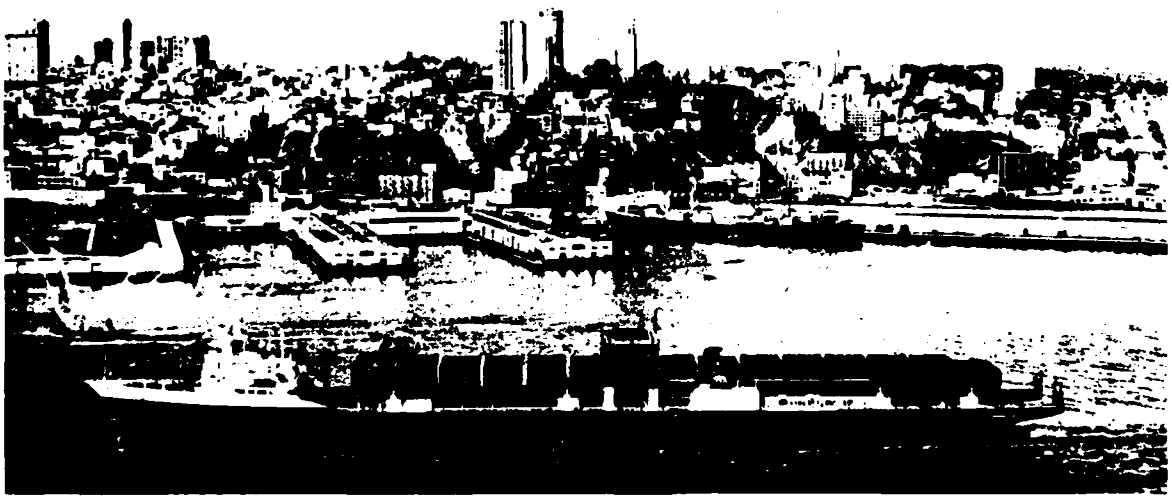

FIGURE 9. LASH SHIP

Figure 10 depicts a roll-on/roll-off (RO/RO) ship. It is less of a modern evolution than the bargeship, but its military potential (along with its problems) in a LOTS environment cannot be overlooked. Some RO/RO ships have stern access ramps.

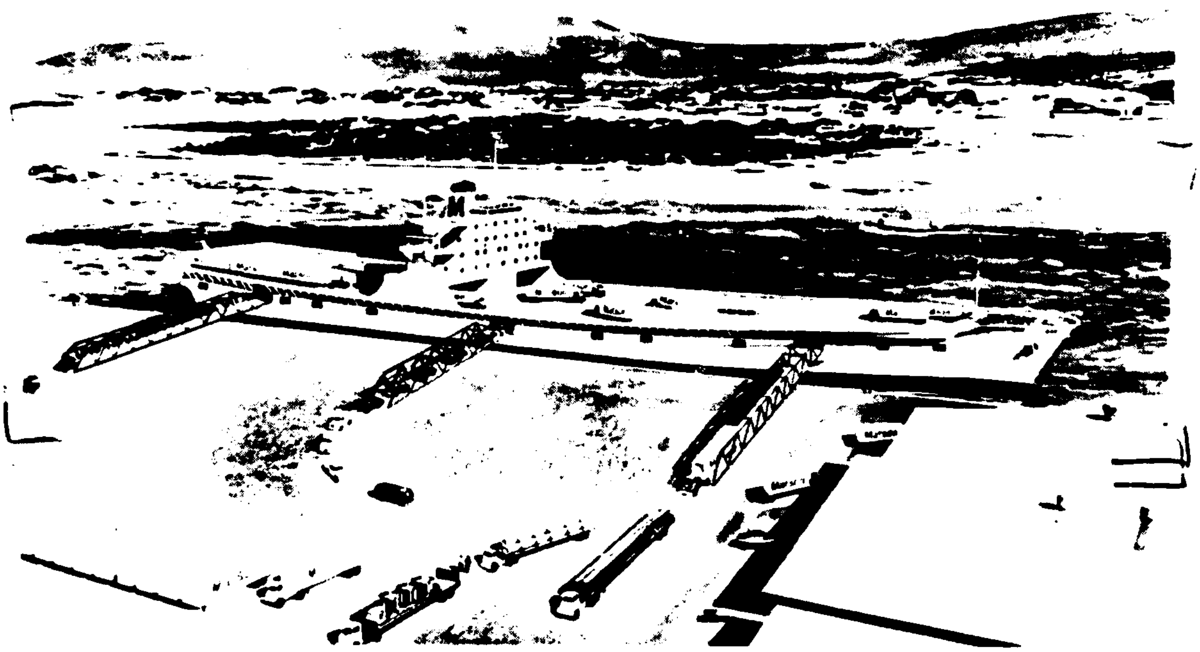

FIGURE 10. MODERN ROLL-ON/ROLL-OFF SHIP

The data in Figure 11 are a quantitative summation of the trends in the characteristics and capabilities of the U. S. flag merchant fleet. They reflect the changes in the size and composition of the general cargo ships over the past decade, and the projected status for 1980. These trends cover a relatively brief span of time, but some of the changes are dramatic, such as:

- The decline in breakbulk ships. These ships, long the backbone of contingency sealift capability, are disappearing from the seas. The 75 percent decline in breakbulk assets in just 10 years is only a part

of the picture. No new breakbulk ships are under construction or planned for construction in the future. Also, many of the residual assets are being increasingly employed in a form of scheduled service. The once plentiful "tramp" fleet readily available for hire anywhere, anytime, is essentially a thing of the past.

- The growth of the containerships, an increase of over 300 percent in a decade, over 80 percent of which are the non-self-sustaining type.
- The advent of the bargeships, SEABEE and LASH, none of which were in service in 1965, and the gradual but steady increase in the roll-on/roll-off ships. The only ships under construction or on order in U. S. shipyards are the "intermodal" types.[2/]
- The last entry in Figure 11 reflects the decline in the lift capability of the current and projected fleet. Equally significant is that the breakbulk ships, which accounted for approximately 90 percent of the productivity of the 1965 fleet, represent only about 30 percent for the 1975 fleet.

TYPE	1965	1975	1980
BREAKBULK	603	166	147
CONTAINERSHIPS	26	115	104
SELF-SUSTAINING	(22)	(21)	(13)
NON-SELF-SUSTAINING	(4)	(94)	(91)
BARGESHIPS	0	22	23
ROLL ON/ROLL OFF	6	9	12
TOTAL LIFT CAPACITY - MILLIONS OF M/T	9.2	6.4	5.7

FIGURE 11. U. S. MARITIME DRY CARGO FLEET

2/ MARAD information sheet.

One last observation concerns surface distribution trends and involves a logical outgrowth of the containerization developments. In order to capitalize on its benefits, the DOD is committed, as a matter of priority, to the establishment of a container-oriented surface distribution system. Figure 12 is a clear indication that the over-ocean portion of that system is well underway, with over 60 percent of defense export cargos moving in containers. Thus, it is not only changes in transportation means that influence the parameters of the LOTS problem; but the supply distribution system with its myriad of associated handling equipment, facility configuration, packing, documentation, shipping costs, order and shipping times, and supply policies and procedures, which increasingly are geared to a container concept.

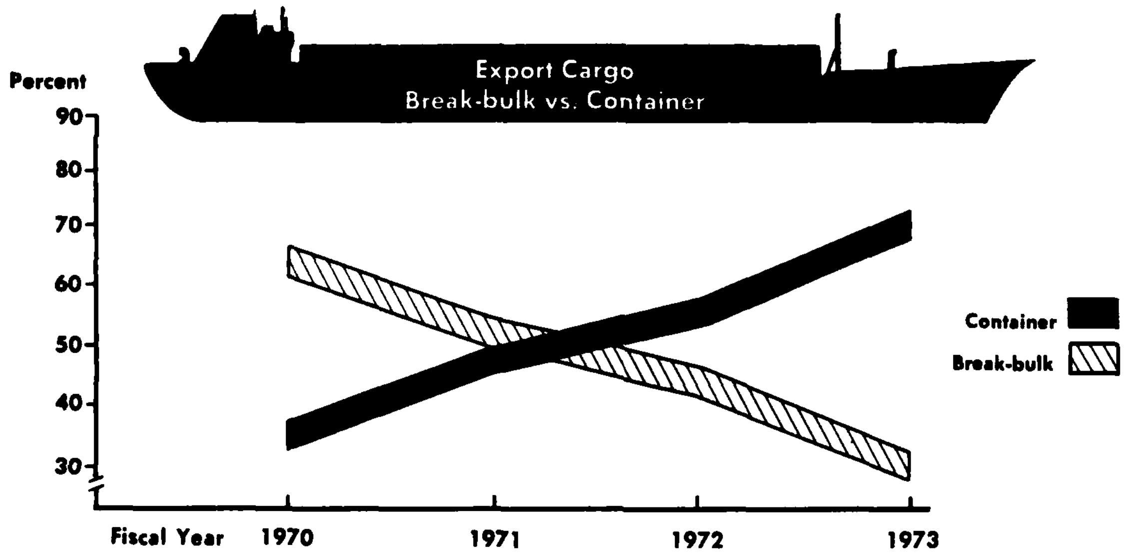

FIGURE 12. TRENDS IN DEFENSE EXPORT CARGO SHIPMENTS

The preceding discussion contains only some highlights of technical developments in transportation and supply distribution that accentuate the LOTS-container problem. It also touches on the related DOD policy implications. Both policy and technology hold the potential for much greater productivity in the over-all distribution system to support military requirements. But in those

instances where fixed container terminals are non-existent or denied, the policy and technology also contribute to a significant problem. It is not the policies that are at issue in the LOTS evaluation, but rather the capability to adapt to them.

SERVICE ROLES, INTERESTS, AND RESPONSIBILITIES

Definition

The term "Logistics-Over-The-Shore" (LOTS) is formally defined in the JCS Dictionary of Terms for Joint Usage as, "the loading and unloading of ships without the benefit of fixed port facilities in friendly or non-hostile territory and in time of war during phases of theater development in which there is no opposition by the enemy." Essentially, this is the definition within which this study has been framed, but with an interpretation for test purposes that takes into account certain changes that have occured since the definition was formulated. New ships were optimized to increase productivity by increasing payload and decreasing turn-around time (loading and unloading). To achieve this, ships have become specialized elements of a systems approach to transportation and handling. Similarly, a meaningful evaluation from a systems view must include more than merely the "loading and unloading of ships". It should as a minimum address the deployment of the LOTS system elements and the interface with the cargo distribution system ashore.

Interests

Fundamentally, each service has a primary interest in the logistic support of its own forces and, accordingly, a basic stake in the capabilities of a LOTS system to support those requirements. Historically, for military operations overseas, approximately 95 percent of the cargo moved has been shipped by surface means. With the recent and projected increases in airlift capability some minor contingency planning estimates run as low as 75 percent for surface movement, still requiring a significant sealift effort. Service interests in the past have usually not focused on problems related to surface shipping except where support has been slow or congestion has occurred. Breakbulk shipping has always provided a relatively flexible means of support, although it has often been less responsive than desired and the frequent handlings involved have complicated the problems of cargo damage and cargo identification. Nevertheless, the services have always been able to operate for sustained periods, under the most demanding environmental conditions. However, the policies and trends outlined in this section have focused service attention on the more recent real world problems associated with commercial transportation systems, systems without which the services

could not logistically sustain themselves. And, without an adequate LOTS capability, they are logistic systems which are vulnerable to a variety of factors -- military, political, economic and environmental.

Roles

The basic roles of the services in a LOTS operation can be summarized in terms of a port operator and a transportation agency. DOD Directives designate the Army as the common-user ocean terminal operator and the Navy as the manager of the ship support needed to meet military sealift requirements. In practice, service roles are relatively broad and, in fact, both roles and resources overlap in certain areas. One such area is lighterage, which the Navy requires for support of the Marine Corps, and the Army requires for the conduct of ocean terminal operations. Another example is the operation of commercial cargo handling equipment aboard ship, which is accomplished by the Army transportation terminal service units in LOTS and port operations, and by the Navy in amphibious support operations. The Marine Corps provides its own shoreside handling, since off-loading is closely linked to combat resupply and the amphibious build-up. This overlapping of resources and responsibilities is required for the services to conduct their separate missions. Thus, although operating techniques may be similar, service roles and capabilities are closely linked to the mission assigned. The Air Force by joint agreement will normally have its LOTS support provided by the Army, or in special situations, the Navy.

Responsibilities

Service responsibilities in the conduct of LOTS operations have been jointly agreed upon and published[3/]. Briefly summarized, the joint regulation defines LOTS operations in terms of an operation which may be conducted by one service which is supported by, or which is conducted in coordination with, another service. LOTS nearly always is a joint operation because the Army is the common-user ocean terminal manager and the Navy, through its MSC element, is responsible for the chartering of commercial shipping or tasking of nucleus MSC ships to support sealift requirements. Related to LOTS is the amphibious operation, which during its assault follow-on and resupply phases, takes on the characteristics of a LOTS operation. In the latter phases of the amphibious operation, when commercial shipping is involved, the Navy and Marine Corps employ resources similar to the Army's terminal service units to conduct the LOTS-related operation. By the same token, subject to force availability and joint service agreement, the joint directive provides for Navy support to the Army in a coordinated joint LOTS operation.

3/ Army Regulation No. 55-176, OPNAV Instruction 4620.6A, and Air Force Regulation No. 75-4, Transportation and Travel, Logistics-Over-The-Shore, 8 September 1970.

ADEQUACY OF CURRENT DATA (PREVIOUS EVALUATIONS)

As a result of the broad based service interests previously described, a number of studies, developmental programs, and two dedicated LOTS joint exercises have been undertaken in the past several years. These included both individual and collective efforts by the services aimed toward establishment of a LOTS capability. Abstracts of the more relevant efforts are included in Appendix B.

The specific area most pertinent to the joint LOTS test definition is the adequacy of data generated by exercises and evaluations of service LOTS capabilities in a field operating environment. On this basis, the two previous Offshore-Discharge-of-Containership exercises, OSDOC I and OSDOC II, are of major interest. The data developed in a variety of smaller, independent LOTS-related evaluations and the few LOTS-type operations that have been included as part of larger, tactically oriented exercises have also been considered. The OSDOC evaluations, particularly OSDOC II, have been singled out because of their joint orientation, and attempts toward LOTS system-oriented investigations.

OSDOC I

OSDOC I, conducted in late 1970 (covered in more detail in Appendix B) marked the first field evaluation of the container-LOTS problem by the military. It was an effort much needed at the time but limited in scope (see Figure 13). OSDOC I confirmed suspected voids in the ability of the services to cope with containers in a LOTS environment. Because it was conducted on short notice, test procedures and data collection were incomplete and no meaningful quantitative analysis was possible. It did serve to focus high-level attention on the LOTS problem, probably its most notable achievement and adequate justification for its conduct.

- **SELF-SUSTAINING CONTAINERSHIP**
- **LEASED CONTAINERS & HANDLING EQUIPMENT**
- **ARMY LIGHTERAGE & MHE**
- **CH-47 & CH-54 HELICOPTERS**
- **3 DAY INTERMITTENT OPERATIONS**

FIGURE 13. HIGHLIGHTS OF OSDOC I

OSDOC II

OSDOC II, conducted in the fall of 1972, was a far more extensive effort than OSDOC I. (See Figure 14.) It directly addressed the non-self-sustaining containership problem, employing a variety of exploratory means and techniques for its off-shore discharge phase. OSDOC II was a significant event in the initial shaping of LOTS doctrine and provided insights for LOTS hardware development. In fact, several of the subsystem components and operational techniques proposed for use in the joint LOTS test were introduced and/or demonstrated in OSDOC II, such as the crane-on-deck, crane-on-barge, and air cushion vehicle lighter. There were no LOTS container-capable organizations in the military force structure in 1972. For this reason, virtually all the crane off-load components, the air cushion vehicles and much of the shoreside container handling equipment in OSDOC II were operated and maintained by experienced civilian contractor personnel. This was not necessarily a valid representation of service capabilities. The original objectives of OSDOC II concerning systems' capability were not achievable. The originally designed experiment to test a variety of alternative surface systems was changed to test only the components of the systems non-sequentially. Interactions between the system components were not measured. The adequacy of the data developed can best be summarized in the words of the OSDOC II final report:

"A strenuous effort has been made to obtain as much useful quantitative information from the (OSDOC) experimental data as feasible. Notwithstanding this effort, the experimental data do not provide an adequate basis for making accurate estimates about the system discharge capability for even a few of the systems scheduled for testing in OSDOC II".[4]

- **NON-SELF-SUSTAINING CONTAINERSHIP**
- **LEASED CRANES & MHE**
- **IMPROVISED DISCHARGE FACILITIES**
- **LIGHTERS, HELICOPTERS & COMMERCIAL ACV**
- **6-7 LIMITED WORKING DAYS**

FIGURE 14. HIGHLIGHTS OF OSDOC II

4/ Joint Army-Navy Test Directorate, Offshore Discharge of Containership II, Volume 1-Surface Operations, Appendix II-Analysis of System Discharge Capability. p II-1.

In an effort to bring together the limited and incomplete data generated, the OSDOC II analysis included some rough capability estimates caveated as follows:

"Their [the estimates] primary value is to point up how little can be done with the experimental data now on hand. The need for further performance measurements in this area, either on field exercises or through experimentation, is clearly indicated".[5]

Data Shortcomings

The inadequacy of data on LOTS systems capability in a realistic operational environment is a primary justification for additional joint testing. The major shortcomings of previous evaluations can be summarized as follows:

- Major subsystem equipment was administratively positioned and operations were artificially started and ended.
- Normal delays were not taken into account in the data, nor in the evaluation of the data.
- Interactions between LOTS system components were not measured, only the critical event times for components *acting independently*.
- Data were developed only for ship-offload, ship-to-shore, and beach handling phases of LOTS operations. The deployment of system components to the operational site, and interface with the supply distribution system ashore were not addressed.
- Container loading for some test lifts was nominal and not fully representative of loads that would realistically be encountered under normal operating conditions.
- No evaluation was made of the effect of simultaneous breakbulk and container cargo operations on distribution, management, and control.
- Limited data generated are based in large part on performance of contractor operated, leased commercial equipment, which is probably not representative of realistic service capabilities.

References to the inadequacies of existing data in no way imply criticism of the previous evaluations. The OSDOC exercises served a much needed purpose, but not the one the proposed joint operational test is to address. Fundamentally they are different from the proposed test. The principal differences are summarized in Figure 15.

5/ Op. Cit., Pg II-5.

DIFFERENCES BETWEEN OSDOC I&II AND PROPOSED JOINT TEST

OSDOC I&II	PROPOSED JOINT TEST
PROBLEM EXPLORATION AND DEMONSTRATION OF HARDWARE AND TECHNIQUES	OPERATIONAL TEST OF SVC CAPABILITY—PLANNING FACTORS, DOCTRINE, MANPOWER, AND ESTABLISHED EQUIPMENT RQMTS.
DEVELOPMENTAL ORIENTATION IN EXERCISE PLANNING MANAGEMENT AND EVALUATION	OPERATIONAL ORIENTATION OF TEST PLANNING, MANAGEMENT AND EVALUATION
RELATIVELY BRIEF INDEPENDENT SUBSYSTEM OPERATION AND MEASUREMENT. INCONCLUSIVE PERFORMANCE DATA	SUSTAINED INTEGRATED OPNS. INTERACTIONS EVALUATED. STATISTICAL VALIDITY
SYSTEM EQUIPMENT ASSUMED IN PLACE AT OPERATIONAL SITE	DEPLOYMENT OF SYSTEM EQUIPMENT TO OBJECTIVE AREA PHYSICALLY TESTED.
NO TACTICAL SCENARIO. (ADMINISTRATIVE PREPARATION OF LOTS SYSTEM ELEMENTS	MULTI-SCENARIO ORIENTATION. (TACTICAL ESTABLISHMENT OF LOTS SYSTEM ELEMENTS)
CONTAINERSHIP ONLY	CONTAINERSHIP, BREAK BULK SHIP, BARGESHIP, RO/RO
SHIP-TO-SHORE EMPHASIS	CARGO PHYSICALLY THROUGHPUT—DISTRIBUTION AND DOCUMENTATION PHYSICALLY TESTED
CONTAINERS WITH NOMINAL LOADING ONLY	REPRESENTATIVE LOADING OF CONTAINERS CARGO MIX: 20'–40' CONTAINERS AND BREAK BULK, SIMULTANEOUSLY
SIGNIFICANT CONTRACTOR OPERATED LEASED EQUIPMENT	TOE UNIT EQUIPMENT AND OPERATORS, SERVICE DOCTRINE
DAYTIME OPERATIONS PRIMARILY	AROUND THE CLOCK OPERATIONS

FIGURE 15. DIFFERENCES BETWEEN OSDOC I AND II AND THE PROPOSED TEST

STATUS OF SYSTEM ELEMENTS

General

In addition to reviewing previous LOTS evaluations and the adequacy of existing systems data, one other major consideration in determining the feasibility of the joint test was the status and availability of LOTS systems elements in the prescribed FY 1976-1977 time frame.

In outlining the status of LOTS systems components in Figure 1, LOTS cargo throughput operations have been categorized into three broad interfacing subsystems (LOTS capable organizations which employ these elements are also indicated). The operational effectiveness of each subsystem impacts on the effectiveness of the other two. The throughput rate of the LOTS system is limited to the maximum capacity (cargo flow rate) of the slowest subsystem. First is the ship unloading subsystem, for which primary interest is centered on the discharge of the non-self-sustaining containership, the most complex aspect of off-shore ship unloading. The second subsystem includes the lighterage used to move cargo from ship-side to unloading points ashore. The third subsystem is shoreside handling, which broadly covers the areas of lighterage unloading, and movement to a marshalling site and/or distribution. Management and control of cargo is a part of all three subsystems but much of this activity is centered in the third subsystem. The first two subsystems are essentially the same whether the Army or the Navy/Marine Corps is involved. Operational differences are mostly in the third subsystem from the time cargo arrives at the beach and increasing as cargo progresses inland. This is attributable to the differing tactical environment in which the Army and Marine Corps normally operate and the correspondingly different operating procedures.

Ship Off-load Subsystem

Because of the inherent capability of the bargeship, breakbulk ship, and RO/RO ship for self-discharge, emphasis is on discharging the non-self-sustaining (NSS) containership. Three approaches to off-loading the NSS ship are, or will be, available in the specified test period.

The first is the crane-on-deck (COD). It uses mobile cranes, loaded on each NSS containership while in port. In effect, the cranes provide the ship with a temporary self-sustaining capability. Two major components to the COD element are required. The first is a hatch cover bridging or deck reinforcing kit being developed by the Navy and forecast to be available in time for LOTS equipment deployment pre-testing in late FY - 76. The second component of the COD is the crane itself. The Navy has considered possible modification of an off-the-shelf commercial crane for use in this ship unloading

approach, but indications are that procurement lead time and subsequent acceptance tests make it doubtful that the Navy crane with or without modifications will be available for testing in the specified test time frame. An organic Army crane, which would not normally be used in the COD role but which is very similar to the Navy crane, will be available for both LOTS systems equipment deployment pre-testing and the main test.

A second alternative element in the ship unloading subsystem is the temporary container discharge facility (TCDF). Long-range container discharge facility (CDF) concepts favor a ship configuration which will not only unload NSS containerships but also deploy other LOTS system equipment. The interim concept is the employment of a crane on a hull or floating platform which would be capable of unloading a containership. For test purposes two components are relevant, the hull or platform, and the crane. The hull/platform could be either a non-self-propelled barge such as a floating Delong barge, or a self-propelled, ocean-going vessel such as the barge discharge lighter John U. D. Page. The projected availability dates of both cranes for the COD and TCDF elements are based on the current organization and procurement schedules for the Army's new container-capable terminal service company.

The third element in the ship unloading subsystem category is the helicopter. CH-47s and CH-54s have been tested in a LOTS role in the past, as was the Marine Corps CH-53D. One new helicopter will be available for test in a container unloading capacity, the Marine Corps CH-53E, which is currently undergoing developmental test and evaluation. It has a design lifting capacity of approximately 16 tons and would be used for transportation of heavy lifts. Helicopters have limited application for container LOTS operations but are suitable for high priority unloading. Their limited quantities and high operating costs tend to militate against their consideration as a major discharge system for sustained operations.

One remote possibility for evaluation is a balloon discharge system, a method that has received considerable attention recently in view of the success with which it has been used in Northwest logging operations[6/]. However, it appears that considerable developmental testing would be required before this system could be operationally evaluated. The estimated availability shown in Figure 1 is not based on any firm program projections.

Ship To Shore Subsystem

The components of the lighterage subsystem available for operational testing include the current inventory items such as the non-self-propelled causeway with tugs, the LCU and LCM8 landing craft, the LARC LX amphibian, and

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6/ H. E. Reed, Ship to Shore Oregon Test Series II Preliminary Report, 20 April 1973, Advanced Research Projects Agency, Office of Advanced Sensors.

new items such as the Army's pre-production model LACV-30 air cushion vehicles, and the Navy's self-propelled causeway ferry.7/

Shoreside Subsystem

There are three major elements of interest in this subsystem, all of which are forecast to be available in the FY 76 - FY 77 time frame. They are: a large mobile crane, which is part of the Army shoreside handling subsystem; the elevated causeway, a Navy developmental effort to facilitate shoreside handling by providing a temporary pier from which smaller cranes may operate; and the Army's Terminal Operations and Movements Management Subsystem (TOMMS), Standard Port System element.

Terminal Organization

In addition to the existing terminal service, cargo handling and port operations, and shore party elements in the service force structure, a major new organization has been developed specifically to interface with surface container-supported distribution systems, the Army Transportation Terminal Service Company (Container). Documentation has been completed, equipment procurement initiated, and organization and unit training will have sufficiently progressed to permit operational testing in FY 1977. Results of the test will be used to refine force structure and unit capability factors. The basic mission of the company is to provide cargo handling in terminal operations, specifically containers. It is responsible for the discharge, backloading, and trans-shipment of containers at water terminals located at either ports or beaches. The company can also sort containers by destination and load containers from the marshalling yard on land transportation, as well as perform limited stuffing and unstuffing operations. The company will also account for all cargo handled as required by MILSTAMP procedures and prepare necessary transportation documentation.

TIMING AND TECHNICAL FEASIBILITY

The most significant observations that can be drawn from the preceding availability projections are:

- That in addition to the conventional organizations and equipment used during the OSDOC II tests, new container-LOTS capable units and related hardware will be available for operational testing during FY 76 - 77.

7/ Late information on the self-propelled causeway indicates that some improvisation may be required to provide a working prototype.

- That these system elements will be representative of the FY 77 - FY 80 service LOTS capability, though not necessarily the optimum system components or at the force level that may eventually be authorized.

These observations tend to point up one significant conclusion -- there is a void in terms of meaningful operational data on the projected in-being or near-time frame LOTS capability. In addition, some significant decisions are due in the next few years, both on the service force structure to provide a LOTS capability, and the quantities of related system hardware now being procured as pre-production models (e.g., LACV-30s) or limited initial buys of off-the-shelf commercial equipment (e.g., container cranes). Such decisions can most prudently be made only if the planning factors, such as system response times and cargo throughput upon which they will be based have some validity -- a validity which should have its basis in quantitatively oriented tests under realistic operational conditions.

Because of their direct relevance to the area of service capabilities, existing planning factors for LOTS organizations and equipment are of special interest in the test definition. Most of the estimates of operational capability of the LOTS-capable elements, of necessity, have been based on extrapolations of commercial container operations at fixed facilities or the very limited OSDOC performance data discussed previously. Some unit capabilities are still expressed in terms of breakbulk tonnage which they were originally designed to transport. Other elements, such as command and control organizations have yet to be physically evaluated as to their capability to manage a mix of container, bargeship, and conventional breakbulk cargo. Figure 16 lists some examples of key LOTS planning factors which require quantitative validation in a realistic operational environment.

UNIT/SUBSYSTEM TO BE TESTED	QUANTITATIVE FACTOR OR CAPABILITY TO BE VALIDATED
TRANS TERM SVC CO. (CONT.) (LOTS CAPABILITY)	1. 300 CONT/DAY DISCH OR RETROGRADE
	2. 150 CONT/DAY DISCH AND RETROGRADE COMBINED
TRANS TERM Bn HQ (2 COMPANY STRENGTH	300 CONT. AND 720 STON GEN CARGO PER DAY DISCHARGE, MARSHAL AND MANAGE SIMULTANEOUSLY
TRANS MED BOAT CO	720 STON PER DAY
TRANS LACV PLAT. (PROV)	240 CONTAINERS/DAY (TENT)
ELEVATED CAUSEWAY SYSTEM	120–180 CONT/DAY (TENT)
CONTAINER MARSHALLING AREA REQUIREMENT	15 ACRES/1000 CONT

FIGURE 16. EXAMPLES OF PLANNING FACTORS REQUIRING VALIDATION

In view of the preceding considerations, specifically (1) the inadequacy of valid operational data for LOTS system capability estimates, (2) the introduction of new service subsystems components since the OSDOC evaluations, and (3) the timeliness of the opportunity and need to operationally evaluate the projected in-being and near-time frame LOTS capability, joint operational testing is considered both desirable and technically feasible in the FY 76 - 77 period. Other considerations concerning means of accomplishing the test, including resource requirements and availability of suitable sealift assets, are addressed in appropriate subsequent sections of the test definition.

IV. MAIN TEST APPROACH

SECTION SUMMARY

Systems Options for Testing

There are several LOTS system equipment and technique options available to the services to conduct LOTS operations but the fundamental functional elements to perform the LOTS task are practically the same. Because resource constraints preclude testing all available components and techniques, the proposed approach is to employ, for test purposes, a representative system; one which embraces the common functional elements, will be available in the test time frame and beyond, and which places test emphasis on the newer systems elements to maximize the utility of test results. That system is depicted in Figure 17.

Measures of Effectiveness

Cargo throughput capability, normally expressed in containers or tons per hour or day will be a major measure of effectiveness for the LOTS test. It must be supplemented with measurements of system deployment response times, accuracy and speed of cargo location and identification ashore, and manpower employed throughout the system.

Operational and Environmental Conditions

LOTS operations are affected by a variety of conditions and variables. Those which can reasonable be altered will be provided for in the test scenarios. To augment and directly supplement field testing, a LOTS system model will be used to investigate a wider range of effects. Tactical scenarios will include a non-mobilization, limited contingency and a general war mobilization setting. Weather and sea conditions, which have a major impact on LOTS, will be thoroughly measured and their effect on system capability determined. Other environmental variables such as off-shore distance, beach gradients, and inland destination distances, will be evaluated by simulation.

Main Test Concept

A main field test off Ft. Story, Virginia during the second half of FY 1977 will include three major areas of evaluation:

- LOTS system deployment capability
- Off-shore cargo discharge capability
- Cargo distribution interface capability.

The main test will include four basic commercial ship types that would most likely be involved in support of LOTS operations, i.e.,

- A breakbulk ship
- A non-self-sustaining containership
- A bargeship
- A roll-on/roll-off ship.

The test will employ service TO&E organizations at authorized levels of equipment and training. It will be conducted using scenario-related warning and deployment times, beach preparation constraints, and realistic command and control of discharge and throughput operations. All exercise cargo will be representatively weighted and fully documented. Service doctrine, procedures and planning factors applicable for the 1977-1980 time frame will be used to determine test force size and capabilities. An illustrative schedule of the main test is shown in Figure 19.

Test Duration

Based on a combination of operational considerations and statistical techniques, tempered by high daily ship cost, the main test duration will be approximately 15 days. The key requirement is the complete discharge of the containership by each of the two major LOTS crane elements. The statistical validity of system performance data should be greater than any previously acquired. More importantly, realistic measurement of all the interacting elements of the system will be made under a most realistic and demanding set of test considerations.

Data Collection

The primary collection effort for the LOTS test will involve trained personnel using logs and worksheets to record times, events and circumstances. Principal instrumentation for collecting test data will be for constant and accurate recording of environmental conditions associated with the test operations.

Resource Requirements

Accurate estimates of test costs cannot be made until more detailed test plans and schedules have been developed. The cost unique to the conduct of a joint test are normally funded by ODDR&E (Test and Evaluation). The service support requirements are typically the additional resources for support of the joint test force. A more detailed discussion of test resource estimates and support requirements is contained in this section of the report.

GENERAL

While there are some differences in the specific service requirements for a LOTS system, they relate primarily to the anticipated operational environment in which the system would function[1/]. The fundamental functional requirements to accomplish off-shore discharge of ships and the subsequent shoreside handling of cargo are essentially the same.

Basically, LOTS system configurations that are technically feasible during the test period include:

- Ships to deploy LOTS system equipment and personnel
- Crane subsystem for ship off-loading
- Craft subsystem for ship-to-shore movement
- Crane subsystem for shoreside discharge
- Beach staging and clearance subsystem
- Management and control system.

1/ Reference is primarily to Navy/USMC requirements in the early support phases of amphibious operations which result from the constraints imposed by tactical considerations. Also significant is that LOTS equipment in follow-on support of amphibious operations has usually been moved to the objective area in specially configured ships, organic to the amphibious forces, while the deployment of Army LOTS equipment must rely on commercial type ships.

Several equipment and technique options are available within some subsystems. The quantity of alternatives reflects both the variety of hardware designed to handle conventional breakbulk cargo, which has been in service inventories for a number of years, and the hardware and organizational developments that have resulted from the containerization requirements.

The variety of options is also indicative of the need for LOTS system flexibility imposed by a range of environmental conditions which might be encountered in actual operations such as beach gradient, off-shore anchorages, sea and weather conditions, and the specific timing, duration, and tactical considerations of LOTS operations.

The constraints of time, and particularly the high daily cost of ship charters, precludes any attempt to test fully all available system components and operational techniques. It is considered practicable, however, to identify major components which, for test purposes, will be fairly representative of the previously described fundamental system elements available for actual operational employment over the next few years. Also, by placing test emphasis on those components most recently introduced into service inventories -- for which additional hardware procurement and organizational structuring is anticipated--the utility of test results can be maximized.

The combinations of equipment, organizations, and techniques expected to be available and those considered particularly significant for testing are shown in Figure 17. The options selected are broadly oriented toward the basic requirements of both a common user type LOTS terminal operation for which the Army has proponency and the related requirements of a Navy/USMC amphibious follow-on operation involving support by commercial type ships provided through the Military Sealift Command.

Test data on other options, or test conditions oriented toward any special service requirement should be considered for test add-ons, if equipment availability and service test program resources permit. However the options selected for priority testing will provide data that can be combined and applied to a larger variety of alternatives, and still constitute a credible evaluation of service LOTS capabilities with a prudent expenditure of resources.

LOTS CARGO DISCHARGE OPTIONS / TYPE SHIP INTERFACE REQUIREMENT	SHIP OFFLOAD						LIGHTERAGE					SHORESIDE DISCHARGE & BEACH HANDLING		CARGO DISTRIBUTION MANAGEMENT	
	CRANE ON DECK (A)	CRANE ON BARGE (A)	1/ MODIFIED CRANE ON DECK (N)	1/ CRANE ON FLOATING PLATFORM (TCDF) (N)	ORGANIC SHIPS GEAR	HELI COPTER (A N)	LAND CRAFT (A N)	AMPHIB (A)	CAUSEWAY FERRY/TUG (N)	BARGE W/TUG (A N)	ACV LIGHTER (A)	BEACH CRANE (A)	CRANE ON ELEV CAUSEWAY (N)	MANUAL (A MC)	ADP (TOMMS) (A)
I NON SELF SUSTAINING CONTAINER SHIP															
• DEPLOYMENT	✓	NA	✓	NA	NA	✓	✓	✓	NA	NA	✓	NA	NA		
• DISCHARGE	✓	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓	✓		
• DISTRIBUTION						NOT APPLICABLE								✓	✓
II BREAKBULK SHIP															
• DEPLOYMENT	NA	✓	NA	NA	NA	NA	✓	✓	NA	NA	NA	✓	NA		
• DISCHARGE	NA	NA	NA	NA	✓	✓	✓	✓	✓	✓	✓	✓	✓		
• DISTRIBUTION						NOT APPLICABLE								✓	✓
III BARGESHIP															
• DEPLOYMENT	NA	✓	NA	NA	NA	✓	✓	NA	✓	✓	NA	✓	✓		
• DISCHARGE	NA	NA	NA	NA	✓	✓	NA	NA	NA	2/ ✓	NA	NA	✓		
• DISTRIBUTION						NOT APPLICABLE								✓	✓
IV ROLL ON ROLL OFF SHIP															
• DEPLOYMENT						(ALTERNATE FOR CONTAINERSHIP OR BARGESHIP)									
• DISCHARGE	NA	NA	NA	NA	NA	NA	✓	NA	✓	✓	NA	NA	NA		
• DISTRIBUTION						NOT APPLICABLE								✓	✓

OPTION LEGEND

- ✓ SYSTEM OPTION
- ✓ PRIORITY OPTION FOR TESTING
- ✓ LIMITED TEST ONLY
- NA NOT APPLICABLE

NOTES

1/ PRIORITY FOR TESTING OVER ARMY TERMINAL UNIT CRANES IF AVAILABLE IN FY 77

2/ ORGANIC SHIPS BARGE

FIGURE 17. MAJOR LOTS SYSTEM OPTIONS FOR JOINT TEST

The constitution of the proposed system for test purposes is simply a technique to provide a means for a credible evaluation of a LOTS capability. It should not be construed as a proposed departure from the currently assigned service responsibilities for LOTS operations. Similarly, it is not intended to imply the desirability or requirement for development of a single LOTS system.

SYSTEMS OPTIONS FOR TESTING

General

As indicated in Figure 17 the representative subsystem elements (ship unloading, lighterage, shoreside handling and control) will be evaluated in terms of their capabilities to be deployed, to be off-loaded in the objective area, and to effectively support throughput and distribution functions. More specific considerations concerning the recommended options for testing are outlined in the following paragraphs.

Ship Unloading

Crane-on-deck. Two options were considered for operational testing. The preferred crane element for unloading is a commercial crane with a deck reinforcing kit being developed by the Navy, but, as previously discussed, its availability for the test is doubtful. The proposed test substitute is an Army crane of comparable commercial design and capability. It is organic to the new container-capable Terminal Service Company and scheduled for delivery in early 1976. The hatch-bridging and deck reinforcing kit required for weight distribution should be available in approximately the same time frame. The current discharge planning factor for a COD is 10-12 containers per crane per hour based largely on experience gained from OSDOC II. Its validity will be evaluated in the operational test in terms of a sustained operation under realistic conditions.

Container discharge facility. The CDF option available for testing is a crane on a barge, referred to as a "Temporary Container Discharge Facility" or TCDF. As indicated, current long-range concepts include a special facility of undetermined configuration to accomplish container off-loading functions. The available TCDF with the highest potential productivity is the crane-on-barge subsystem. This off-load facility employs one of the heavy cranes organic to the Army Terminal Service Company (Container), mounted on a suitable floating platform such as a Delong barge or a BDL (barge, discharge, lighter). Subject to pre-test feasibility, both the crane and the non-self-propelled barge will be embarked aboard, and discharged from, a bargeship as part of the deployment phase of the main test. Once in the objective area the TCDF can be used for other container-related or heavy lift requirements.

The TCDF can readily be positioned anywhere alongside a ship and can also accommodate large (35- and 40-foot) containers. Like the COD, the crane-on-barge (TCDF) is estimated to have a discharge rate of 10-12 containers per crane per hour, based mainly on OSDOC II experience. Determination of a realistic operational rate is one of the joint test objectives.

Helicopter. The option of using helicopters to unload NSS container-ships is a feasible method for ship discharge, provided that the combined weight of the container and the spreader bar (a device used for lifting containers that prevents structural stress and buckling of the container) do not exceed the helicopter's lift capability. Since OSDOC II, new light-weight spreader bars have been developed and tested. In addition, the Marine Corps CH-53E helicopter will be available for the test. It has a design lift capacity sufficient to accommodate the average loaded 20-foot container weights reported by MTMC (see Appendix F) and could be employed in LOTS or amphibious operations if the cargo priority so merits. The helicopter option is acknowledged to be costly in terms of a sustained operation, but it is an expedient means of unloading high priority cargo rapidly. Only limited testing of this option is proposed, primarily to determine the feasibility of simultaneous helicopter discharge and surface craft operations. (It is planned that the capability of deploying Army helicopters by bargeship will be evaluated as part of a service side-test involving non-self-deployable aircraft.)

Lighterage Subsystem

Deployment. Amphibious ships, for the most part, have sufficient capability to deploy the size and type lighterage required for ship-to-shore operations. This is accomplished with large booms, cranes, and docking wells... features that most merchant ships lack. As noted previously, while amphibious ships are an integral part of an organic Navy-Marine Corps tactical system, the Army must rely primarily on merchant-type ships for its lighterage deployment requirements. The weight of standard service landing craft that are container-capable, such as the LCM8 and LCU, exceed the boom capacities of most merchant ships. However, there are some merchant ships, and methods, by which these craft can be embarked and subsequently unloaded in the objective area. Because of the criticality of lighterage, its deployment aspects will be a major part of the evaluation of this subsystem.

Cargo movement by lighters.

Landing craft. The LCM8 and LCU are employed by both the Army and the Navy and will be in service inventories well into the 1980's. Both craft will be used for container lighterage. In addition, the LCU will be employed to discharge the RO/RO ship in an off-shore environment.

Amphibians. As an alternative within the Army lighterage system, amphibians provide the capability to deliver cargo beyond the waterline, thereby alleviating part of the congestion on the beach that otherwise could result if a preponderance of landing craft were used. Cargo is unloaded from amphibians in the marshalling area. Except for the LACV-30, only one amphibian, the LARC LX, is capable of transporting fully-loaded containers to the marshalling area. Its numbers in the inventory are small. Accordingly, 5- and 15-ton capacity amphibians (LARC-V and XV) are proposed for discharge of the breakbulk ship with the LARC-LX reserved for containers.

LACV-30. The two pre-production models of the LACV-30 will be used in the same capacity as other amphibians, except they will be used mainly for transporting containers instead of breakbulk cargo. For deployment evaluation, the LACV-30 will be carried on the weather deck of the non-self-sustaining containership. 2/

Causeway ferry. The Navy is developing a self-propelled causeway ferry which may eventually be one of the principal means of lighterage. As an interim measure, a tug is now used for propulsion of the pontoon causeway (up to four sections totalling 360 feet are normally employed). Causeway ferry concepts involve shipside loading by either placing containers directly on the causeway or on a chassis (mobile loading). The choice of causeway ferry employment is largely an operational consideration, subject to the situation and asset availability. Causeway ferry operations will be used extensively to unload RO/RO ships. Deployment of the causeway ferry will be accomplished by the bargeship, although other means (such as welding hooks for causeway sections to the side of a breakbulk or other merchant ship) will be investigated in pre-test analyses.

Barge with tug. Bargeship barges have the capability of transporting large amounts of cargo 3/, but lack self-propulsion and are not designed to land at a beach. The Army has no self-deployable LOTS tug designed for handling barges. The Navy has developed a tug adequate for use with these barges. The Navy tug and a number of barges will be deployed and discharged from the bargeship for subsequent unloading by a crane on the elevated causeway. Barges will be transporting both breakbulk and containerized cargo (including 40-foot containers) if pre-test verified.

2/ Subject to pre-test verification. Pre-test analysis may also result in LACV-30 test deployment by other merchant ship types.

3/ LASH barges have a cube capacity of approximately 20,000 cu.ft. each, SEABEE barges 40,000 cu.ft. A LASH may carry from 50-74 barges per ship, depending upon the ship, while a SEABEE carries 38 barges. Bale cube capacity, therefore, could vary from 1 million to 1.5 million cubic feet. Either bargeship could be unloaded off-shore in less than 15 hours.

Shoreside Discharge and Beach Handling

General. Although both the Army and the Marine Corps have varied methods for shoreside handling and cargo distribution, there are operational and equipment similarities between LOTS and the amphibious LOTS-related operation. These can be evaluated in the main test, particularly with respect to barge cargo. The Army, because of merchant shipping limitations, lacks the shoreside equipment deployment flexibility of the Marine Corps with amphibious ship support. Conversely, the proximity of combat operations, and immediate distribution requirements of the Marine Corps make throughput operations more complex, although perhaps not as voluminous as required by Army forces. The backbone of Army shoreside container handling is large (250-ton or 140-ton) cranes. These are positioned on the beach for unloading containers from lighterage. The Marine Corps/Navy approach employs an elevated causeway upon which a crane is placed. The elevated causeway extends beyond the surf line (approximately 6-8 sections or 540-720 feet, depending upon the beach). Lighters moor to the causeway for unloading in a manner similar to that accomplished pierside. The elevated causeway has potential for multi-service use if its potential deployment by merchant ship can be confirmed.

Concurrent Unloading. The capabilities of LOTS systems to concurrently handle breakbulk and containerized cargo across the same beach will be evaluated. The proposed test recognizes the requirement for breakbulk ships for the deployment of LOTS systems equipment, and to transport cargo which cannot be or is not containerized. Until such time as an adequate ammunition restraint system is developed for commercial containers, a considerable quantity of ammunition will be unloaded in the breakbulk mode. Shoreside handling systems, therefore, must be sufficiently flexible in terms of equipment, personnel, and management to cope with the stress of such diverse throughput requirements. Breakbulk handling requirements do not pose any special technical problems for either Army or Marine Corps organizations, since both have routinely employed this mode.

Cargo Distribution Management. Both the Army and Marine Corps have manual capabilities for LOTS system management. The Army also has an automated system for remoting its Standard Port System (SPS) from a LOTS site. The system, an element of the Terminal Operations and Movements Management Subsystem (TOMMS), provides the means by which cargo can be identified and controlled whether it is breakbulk or containerized. It consists of a mobile van established ashore that is linked to a computer at an established logistics area. Data are collected by using either electronic reading devices, retrieval of puncn cards, or manually retrieved from breakbulk or containerized cargo upon landing. Both manual and automated systems will be evaluated in terms of the abilitv to locate

and identify cargo and its destination. A requirement for limited, selected unstuffing of containers and distribution from the marshalling site will be accomplished. Such distribution would simulate Marine Corps or Army requirements for distribution from a beach support area.

MEASURES OF EFFECTIVENESS

In the LOTS test definition, emphasis is placed on selecting quantifiable measures of effectiveness for evaluating operational capabilities. Evaluations of previous related exercises have relied heavily on the professional judgment of experienced observers. While such appraisals are useful, and will be required to some extent in the joint LOTS test, the basic approach is to obtain quantitative data that can best support test analyses or be extrapolated to other operational techniques and environments.

The ultimate measure of LOTS operational effectiveness is considered to be the ability of the system to provide adequate and timely support to the deployed combat force. While it is improbable that such an overall measure could be quantified directly, the nearest relevant quantification of such effectiveness is the cargo throughput capability of the LOTS system, normally expressed in containers or tons per hour or day. Thus, time, precisely recorded and identified with each cargo module (containers/tonnage) at each link and node of its movement, will be a major measure throughout the test.

System throughput is not, however, a complete measure of effectiveness. For example, the facility and speed of deploying LOTS system equipment to the objective area is a major consideration, as is the ability to accurately identify and distribute cargo after it is landed ashore. Principal measures of effectiveness for these areas will be deployment response times and the probability of success in performing essential functions of cargo identification, supplemented by other measurements of time as required.

To assess the force structure and manpower objectives set forth in the test guidance, measurements of time will be supplemented with detailed records of manpower resources employed at each operational link and node of the systems tested, together with related supervisory and support personnel requirements. Because resource constraints will limit the physical size and duration of the tests, overall force structure evaluations will be made by extrapolation of the manpower data collected.

The scope of the objectives set forth in the tasking directive, coupled with the broad spectrum of LOTS systems options and interfaces, requires a focus of test effort if the results are not to be fragmented, as has occurred in previous LOTS evaluations. The proposed approach concentrates on obtaining

the most meaningful quantitative data on a representative system, with the expectation that the services or other participants will record information of specific concern in the more subjective areas. A more detailed discussion of measures of effectiveness is contained in Appendix C. It includes some potential composite or calculated measures and other information that may be derived from test results and analysis.

The fundamental data and the derived information from the joint LOTS test are intended to provide the following:

- An overall determination of the capabilities of a LOTS system representative of that which will be available to the services in the 1977-early 1980s time frame, specifically its responsiveness, productivity, and reliability.
- More accurate and reliable information on equipment performance when fully integrated into a system structure and stressed in a realistic operational environment.
- The first realistic assessment of LOTS unit capabilities, not only in terms of quantitative throughput, but including the effects of organizational structure, command and control, doctrine and procedures.
- The first operational evaluation of the capability to deploy LOTS system elements with the most likely available sealift assets, and to determine its impact on system cargo discharge concepts and capabilities.
- A determination of the effectiveness of the system tested to identify and control the cargo put ashore and its compatibility with existing supply distribution concepts.
- The development of a LOTS system simulation model incorporating realistic, actual performance data which can be used to (a) provide a wide range of comparisons of a variety of system component mixes, operational conditions, and throughput requirements; (b) the model may also be used to assist in the initial evaluations of new system components without resort to field testing with all interfacing system elements. Finally, it will have a potential to assist joint and service operational planners in developing LOTS force requirements to meet specified requirements or to determine the capability of a LOTS force in a given situation.

In addition to validating LOTS system capability, the test results should provide data that can be used by the services for further development of optimum techniques, procedures, concepts, equipment, and organizations.

ENVIRONMENTAL AND OPERATIONAL CONDITIONS

General

LOTS operations are affected by a large number of conditions and variables. In a totally thorough evaluation of the entire spectrum of possible LOTS operations, all these conditions and variables would be altered, both to measure the possible spread in test results and to identify promising means of improving the system. It is obviously impractical, however, to attempt to investigate every conceivable possibility by field tests. The constraints of time and resources limit the variety of conditions (e.g., ship-to-shore distances) and some are largely beyond control of the test program (weather and sea conditions). Those conditions that can reasonably be altered will be provided for in the test scenarios. Use of a LOTS systems throughput model is proposed as a practical means of investigating a wider range of effects, to augment and directly supplement field testing, as discussed in a previous paragraph.

Strategic and Tactical Setting

One of the major tasks in the LOTS test definition was that of scenario development. It was intended to:

- Assist in identification of requirements and parameters of anticipated LOTS operations.
- Provide a probable and realistic mission framework for the overall test design.

The jointly developed and approved real-world contingency plans would appear to be ideal as a direct source for LOTS test scenario development. However, there are a number of problems and considerations that limit the utility of this approach. They are also indicative of some of the difficulties in LOTS problem definition.

Contingency plans at the JCS level are broad in scope, and properly so. They are essentially concept plans which deal in summarized and aggregated data, particularly concerning their logistics aspects, which are treated as areas of primary service interest. In some instances, planning assumptions

regarding the types of ships employed and the existence of transportation facilities and handling equipment in objective areas are acknowledged to be artificially unconstrained. This may appear to be an oversimplified approach, but LOTS capabilities, while accepted as an essential but generalized requirement, are not normally quantified in basic contingency plans. There are a variety of specific scenario settings under which LOTS operations might be required. Figure 18 is a list of typical conditions and an indication of their relative likelihood of occurrence considering current U. S. strategic concepts.

In order to span this broad range of contingency situations under which LOTS operations might be conducted, two basic scenario orientations are recommended.

Non-Mobilization Scenario. The first test setting is a non-mobilization situation where U. S. national authority to acquire sealift assets is limited, as is the scope and duration of anticipated military operations. This is in contrast to a general war or major contingency situation which results in mobilization and the unlimited authority to requisition commercial ships with self-sustaining capability; or where LOTS operations are conducted subsequent to an amphibious landing and residual semi-fixed facilities lifted by special amphibious ships are available; or where operations are more likely to occur in an economically developed area with improved discharge facilities. For these, the LOTS system deployment problem will be facilitated.

But in order for the joint test to address the most demanding situation (and the most probable - see Figure 18) the key elements of the non-mobilization scenario must be included, particularly:

- The most urgent time requirements for the establishment of a LOTS capability in the objective area.
- The limits of only opportunely available MSC ships and those offered by private owners under current sealift readiness programs.
- The constraints of marginal or non-existent fixed ports.

Mobilization Scenario. The second basic scenario setting envisioned in the joint test is that associated with a major contingency: the declaration of a state of mobilization, including governmental requisitioning authority for ships; and sustained military operations on a large scale. Assumption of a mobilization setting serves several test purposes: it insures that organizations and systems components will be required to function in a more complete range of operational environments; it provides for the introduction of additional ship types (the availability of which might be unrealistic in an abbreviated non-mobilization scenario); and it will accommodate both the LOTS-type operations of an amphibious follow-on and the use of pre-existing facilities, whether or not an amphibious assault is involved. (See Figure 18).

A

MOBILIZATION
(General War)

LOTS Operations:

1. Which follow an amphibious assault
   - With Facilities left in place.
   - Without residual facilities.
2. Which follow non-assault initial deployment into fixed port - later denied.
3. Into marginal fixed facilities requiring LOTS-type discharge augmentation.
4. Into developed area where fixed facilities are initially denied.

B

NON-MOBILIZATION
(Lesser Contingency)

LOTS Operations:

1. Which follow initial non-assault deployment to undeveloped area - no usable facilities.
2. Following initial deployment to fixed facilities - subsequently denied.
3. Subsequent to deployment into fixed facilities in adjacent area - (Transshipment).
4. Which follow an amphibious assault
   - With facilities left in place.
   - Without residual facilities.

FIGURE 18. TYPICAL TACTICAL SETTINGS FOR LOTS OPERATIONS

Variables affected by scenarios. In addition to providing for the introduction of variables such as ship availability, ship types, and time constraints, the range of tactical settings described above is desirable for another essential element of the LOTS evaluation. In order to make the most meaningful evaluation of total systems effectiveness and suitability, it will be desirable to investigate the relative impact of certain overall variables associated with the choice of scenarios. These include: total tonnage throughput requirements, container distribution concepts, and command and control structure. By combining the operational features of both scenario settings in a single field test, and addressing the impact of other variables by supplementary analyses, this level of comprehensive analysis can be made.

Environmental Considerations

Physical features. A major challenge in the LOTS test definition is to accommodate the variety and range of operational conditions imposed by the physical features of areas where LOTS operations may be required. These conditions are frequently major determinants of the operational suitability and effectiveness of certain LOTS subsystems, for example, ship-to-shore distances or inland destination distances for cargo.

Because of the obvious cost constraints of employing several different test sites in order to vary such conditions, or the time loss and disruptions that would result from frequent repositioning of ships, the effect of many of these variables can be more prudently acquired by simulation techniques. As mentioned previously, a LOTS system model to assist in a more complete range of these and other scenario related investigations is feasible and considered to be a necessary supplement to the field test.

Weather and sea conditions. These are two other important variables, both of which have a major impact on LOTS operations. While susceptible to quantitative measurement, both are largely beyond the control of the test program.

To collect the most meaningful range of LOTS operational data, it would be desirable to have the field test span a total spectrum of weather and sea state, from absolute calm to adverse conditions that severely limit, if not preclude, throughput operations. On the other hand, if the test period is selected to maximize the probability of some occurrence of adverse conditions, the entire test could be jeopardized if they persisted to the point where steady state operations were frequently interrupted, or overall test replications reduced to an invalid sample size.

The most feasible approach, consistent with other scheduling requirements, is considered to be the selection of a main test period that affords the greatest probability of favorable operating conditions, with a chance for more demanding conditions. Data from the recommended test site area indicates that over an 8-10 day period, there is a strong likelihood of sea conditions which would significantly slow operations. Indications are also that such conditions do not normally persist for a full day. Comprehensive weather and sea condition measurements will be made and their effect on system(s) capability determined.

Other test conditions. Other guidelines on test operating conditions are included in the sections on test procedures and data collection. In addition, a detailed discussion of container size and weight for test purposes is included in Appendix F.

MAIN TEST CONCEPT

In order to physically stress the representative system selected for evaluation under realistic operating conditions, a main LOTS field test is proposed. It would be conducted during the second half of FY 1977 off the beach at Ft. Story, Virginia. Its final design will be shaped by selected preliminary tests, identified and discussed in a subsequent section of this report. Site selection factors are contained in Appendix G.

Test Procedures

The following test procedures and criteria are proposed to insure the attainment of test objectives and the realism of the test parameters:

- The main field test will comprise three major areas of LOTS functional evaluation:
  - Physical deployment of selected LOTS system equipment and personnel to the operational site and the establishment of an off-shore discharge capability.
  - The off-shore discharge of one of each of the four specified commercial ship types (non-self-sustaining containership, breakbulk ship, bargeship and roll-on/roll-off ship) that are most likely to be employed in actual LOTS operations.
  - Selected physical distribution and management of LOTS delivered cargo.

- The test will be conducted in a multi-scenario setting. Initial operations will be conducted in essentially a bare-beach environment, representative of a non-mobilization contingency in an undeveloped area. The test setting will transition to a mobilization scenario in which there is a semi-improved beach environment, with the establishment of a mobile pier facility. These conditions are intended to be representative of the follow-on phases of an amphibious operation or LOTS operations where minimal pre-existing facilities are available.

- The scheduling and sequencing of the commercial ships in the test event schedule should be in conformity with the approved JCS forecasts of sealift assets for the two strategic scenario settings involved.

- Two basic containership off-load systems will be employed:

  . crane-on-deck

  . crane-on-floating platform (TCDF).

  Each off-load system will complete one entire ship discharge cycle[4/]. Sequence of employment should conform to realistic projections of arrival time in the objective area under the multi-scenario setting. The bargeship and breakbulk ship will use organic systems for cargo discharge. The roll-on/roll-off ship will require lighterage connection.

- Cargo discharge will be so scheduled as to insure the earliest practical introduction of a mix of container and breakbulk cargo into the beach handling system.

- The final allocation of lighterage for ship-to-shore movement will be partially dependent on pre-test results. However, priority of utilization for containership discharge should be to the air cushion vehicle unit, the causeway ferry, and LCU's. Amphibians and smaller landing craft may be used for breakbulk operations. To insure comparable test data, relatively equal workload assignment of priority lighterage is required.

- Except for obvious exceptions involving commercial ships and possible outloading at commercial facilities, the tests should employ service TO&E organizations with authorized

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4/ See Appendix E for Test Replication Requirements.

levels of personnel and equipment (or project stocks) which will be available for operational testing by mid-FY 1977.

- Exercise of command and control for conduct of operations during the test should be as realistic as possible. Selected test back-up systems and equipment should be provided for in test contingency plans, but systems capability evaluation should include the effects of decision making, communications, and unit procedures. See Appendix C for additional discussion.
- The level of training of participating service units and personnel should be representative of the required readiness standards of organizations with LOTS mission.
- Warning time for unit and equipment deployments to initial operation/departure locations will conform to current contingency movement planning assumptions. Adjustments may be allowed to compensate for peacetime administrative limitations such as: movement clearance by local traffic authorities; use of commercial facilities; and for special cost avoidance considerations (e.g., civilian overtime).
- Beach engineering preparations may be performed by service elements landed during the deployment test phase or by units introduced administratively into the operations site, providing the latter are constrained to realistic scenario arrival time by another transport mode, such as airlifted engineer detachments.
- Depending upon the type containership made available for the main test, 450-600 20-foot MILVANS will be used as test cargo. Container loads will be representative of current operational experience. A weight loading guide is shown in Appendix F. Containers will be randomly located in ship cells. Based on pre-test results, approximately fifty 40-foot leased commercial containers may be test cargo add-ons. They may be deck loaded, used as bargeship cargo, or mobile loaded on the RO/RO ship (or combination of these alternatives).
- Breakbulk test cargo will include representative quantities of major classes of supply based on scenario-compatible planning factors for resupply operations.

- Bargeship cargo will include mixed loads of container and breakbulk cargo. Subject to pre-test evaluation, roll-on/roll-off exercise cargo will be limited to selected self-propelled heavy and outsize vehicular (tracked and wheeled) cargo.
- All test cargo will be documented and manifested in accordance with current MILSTAMP/service procedures.
- Service doctrine, procedures, and unit/equipment capability planning factors expected to apply in the FY 77 - 80 time frame will be used to determine size of test forces and supporting facilities.

Illustrative Schedule

Figure 19 is a day-by-day, illustrative schematic of the main field test. This is a visualization of the schedule and sequencing of the test event highlights that would conform to the criteria and guidelines outlined in the preceding sections.

The blocks with diagonally shaded borders in Figure 19 cover the system deployment test phase, which is designed to evaluate the feasibility, level of effort, and response time, in lifting LOTS outsize and heavy equipment and making it ready for use. Both a containership and a breakbulk ship are used for deployment to the operational site and offloading such equipment in an unimproved beach environment (non-mobilization scenario). This is followed by a second phase deployment evaluation of the lift of the heavier LOTS system components (e.g., elevated causeway) in a mobilization setting using a bargeship. In this illustrative schedule, the roll-on/roll-off ship is depicted discharging only vehicular resupply cargo. However, the ship is also a candidate vessel for LOTS system deployment lift. Selection of type ships for the two scenario settings is based on current availability projections of MSC controlled fleet assets and the commercial sealift augmentation program (Sealift Readiness Program - SRP).

Cargo discharge test operations shown by the dotted borders in Figure 19, begin on the seventh test day (T + 6) with the discharge of the breakbulk ship, followed on T+7 by the start of containership discharge. Discharge rates for both ships are based on current service planning factors for the appropriate terminal service units (conventional and container companies) to be employed in the test[5/]. During this "bare beach" phase of the discharge evaluation

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5/ LOTS discharge planning factor for breakbulk cargo is actually 500 S/T per Terminal Service Company per day. Because breakbulk cargo is introduced primarily to evaluate the ability to handle a mix of cargo, breakbulk tonnage throughput has been scaled down in interest of economy.

TEST DAY	T DAY	T +1	T +2	T +3	T +4	T +5	T +6	T +7	T +8	T +9	T +10	T +11	T +12	T +13	T +14	T +15
NON-MOB SCENARIO DAY			D + 11	D + 12	D + 13	D + 27	D + 28	D + 29	D + 30	D + 31	D + 32					
SHIPS							LCM AMPHIB	LCM AMPHIB	LCM AMPHIB							
BREAKBULK (HVY LIFT)	LOAD 300 S/T EXERCISE CARGO	LOAD 300 S/T EXERCISE CARGO	LOAD BEACH CRANE & LCU (2) LARC LX	SAIL TO TEST SITE PREP. TO OFF LOAD	OFF-LOAD LCU & BEACH CRANE	BEACH PREP & ORGANIZATION	DISCH 150 S/T EXERCISE CARGO	DISCH 300 S/T EXERCISE CARGO	DISCH 150 S/T EXERCISE CARGO (SAIL)							
								CRANE-ON-DECK				CRANE-ON-BARGE (TCDF)				
								ACV LCU	ACV LCU HELO	ACV LCU	ACV LCU HELO	ACV CW FERRY	ACV CW FERRY LCU	ACV CW FERRY		
NON-SELF SUSTAINING CONTAINER SHIP			LOAD TEST CONTAINERS & CRANE-ON-DECK		LOAD LACV & LIGHTERS	SAIL TO TEST SITE PREPARE TO OFF-LOAD CRAFT	OFF-LOAD LOTS-SYSTEM CRAFT	DISCH 150 CONT.	DISCH 300 CONT.	DISCH 150 CONT. RETRO 150	RETRO 300	DISCH 150 CONT. RETRO 150	DISCH 300 CONT.	DISCH 150 CONT. (SAIL)	OFF-LOAD CRANE POST EXERCISE INSPECT	
MOBILIZATION SCENARIO DAY							D + 40	D + 41	D + 42	D + 43	D + 44	D + 57	D + 58	D + 59	D + 60	D + 61
											LCU	TUG	TUG			
BARGESHIP								LOAD CAUSEWAY & CRANE/BARGE & NSDA (OPTION)		SAIL TO TEST SITE PREPARE FOR OFF-LOAD	OFF-LOAD CAUSEWAY & CRANE/BARGE	DISCH SHIPS BARGE FLY-AWAY ACFT	DISCH SHIPS BARGE RECOVER BARGES	(SAIL) POST EXERCISE INSP		
ROLL-ON ROLL-OFF SHIP												LOAD VEHICLES & EQUIP (EX CARGO)	SAIL TO TEST SITE PREP TO OFF-LOAD	OFF-LOAD TO LCU	OFF-LOAD TO CW FERRY	
CARGO DISTRIBUTION							CRANE ON BEACH					CRANE ON ELEVATED CAUSEWAY				
BEACH MARSHALLING SITE						AREA PREP & ORGANIZATION	RECEIVE 150 S/T	RECEIVE 300 S/T 150 C	RECEIVE 150 S/T 300 C	RECEIVE 150 C 50 CR RETRO 150	RECEIVE 50 CR RETRO 300 C	RECEIVE 150 DD 50 TRANS 50 RETRO 150	RECEIVE 300 C DD 50 TRANS 50	RECEIVE 150 C DD 50 TRANS 50		
INLAND SUPPLY FACILITY								REC 50 S/T	REC 100 S/T REC 50 C	REC 50 C RET 50 C		REC 100 C	REC 100 C	REC 100 C		

DEPLOYMENT

CARGO DISCHARGE

DISTRIBUTION

FIGURE 19. ILLUSTRATIVE MAIN TEST SCHEDULE

(T+6 to T+9) containership off-loading will be accomplished by the crane-on-deck subsystem. (The breakbulk ship uses organic gear for conventional cargo discharge.) Lighterage operations will be performed by approximately equal combinations of LACV-30s and LCUs. Amphibians and LCMs, relatively inefficient for container cargo, will be used to discharge the breakbulk ship. Helicopters will be used only to create test conditions of simultaneous air-surface operations, not as a major ship discharge system.

The breakbulk ship completes discharge and sails on T+8. Between T+9 and T+11, exercise play transitions to a mobilization scenario and a semi-improved beach environment. The bargeship completes its deployment test phase (T+7 to T+10) with the off-loading of the elevated causeway components. Once the causeway is erected, discharge to the causeway commences on T+11 with initiation of the second cycle of containership off-loading. This sequence is accomplished by a crane-on-floating platform subsystem. The latter subsystem is brought to the site in a SEABEE ship, if available -- if not, it is towed to the exercise site using real time scenario assumptions. The bargeship discharges a limited number of its organic barges to be worked at the elevated causeway. An optional discharge side-test involving non-self-deployable aircraft (NSDA) would also be completed during this phase. The cargo from lighters supporting the crane-on-floating platform is unloaded both at the elevated causeway and by the beach crane. The lighters would again include mixes of LACV-30s, and a causeway ferry (in lieu of LCUs) in order to evaluate relative performance under similar conditions. The ferry and LCU will be required for RO/RO ship discharge which begins on T+13 with off-shore "marriage" operations to these craft. The containership, bargeship, and RO/RO complete discharge and sail for post-test inspection on the dates indicated.

Cargo staging and distribution operations, shown in checked borders at the bottom of Figure 19, begin on T+6 with the receipt of the first breakbulk exercise cargo. Simultaneous receipt of breakbulk cargo and containers occurs on T+7. Inland shipment of containers (sample quantity) begins on T+7. System saturation occurs on T+9 with the addition of retrograde operations; this state is maintained through T+12 when cargo discharge terminates.[6/] Other test requirements will concentrate on the ability of shoreside elements to rapidly and accurately locate and identify cargo (including operations such as selective container unstuffing, redocumentation, and cargo diversion).

6/ Container retrograde during this scenario time frame is required for exercise purposes primarily. The containership would probably return empty during the early stages of a LOTS operation, particularly in a limited contingency.

Test Duration

The duration of the main test was determined by a combination of operational considerations and statistical techniques. The results from both were tempered by the high daily cost of chartered ships.

As indicated in the illustrative test schedule, the off-loading of a non-self-sustaining containership is the central and controlling element in fixing the duration of the joint LOTS test.

Total test time requirements comprise the five days, T to T+5(to outload test cargo and LOTS equipment and deploy it to the operational site), and seven days to accomplish one complete discharge cycle of a notional 600-container ship, using each of the two major LOTS crane off-load subsystems. (See Figure 20.) Only by requiring each crane subsystem to function through one entire ship discharge cycle with its attendant start-up constraints, variety of deck and hatch configurations, changing freeboard and stability as the ship empties, and the requirement to span a minimum time range to achieve some measurable difference in sea states, will the minimum essential operational demands be encountered.

	DISCHARGE BY CRANE-ON-DECK				DISCHARGE BY CRANE-ON-BARGE (TCDF)			
TEST DAY	6	7	8	TOTALS	10	11	12	TOTALS
LIGHTER:								
LACV–30	70	135	75	280	75	135	70	280
LANDING CRAFT	80	135	75	290	–	–	80	80
CAUSEWAY FERRY	–	–	–	–	75	165	–	240
HELICOPTER	–	30	–	30	–	–	–	–
	150	300	150	600	150	300	150	600

(YIELDS POTENTIAL VARIANCE OF LESS THAN 10% AT 95% CONFIDENCE LEVEL EXCEPT FOR HELICOPTER)

FIGURE 20. JOINT LOTS TEST SCHEDULE OF LIFTS FROM CONTAINERSHIP

As a corollary to these operational considerations, and to determine the accuracy and reliability of the data from the number of proposed test replications, sampling techniques were applied. The results indicate that the potential error in crane performance measurements with this number of repetitions will be generally less than 10 percent. Limited analyses of the effect of potential errors on both ship queuing and force sizing were made which tend to verify a need for measurements at this general level of accuracy.

However, a necessary qualification is essential. It would be unrealistic not to assume that a test of this nature will involve equipment failures, human error, and other unforeseen delays and interruptions. The data sample size is secondary in a sense. Even with major stoppages, the statistical validity of the data acquired should be greater than that collected previously. But most importantly, this is an operational test and should reflect operational considerations primarily. It is considered that the proposed test duration is sufficient to meet both goals. A further discussion of some of the implications of the nature of an operational test (as opposed to a development test) is contained in Appendix C. A more detailed discussion of test replications is contained in Appendix E.

DATA REQUIREMENTS AND COLLECTION

The LOTS test definition tasking did not include requirements for detailed data collection design. However, to provide guidance for subsequent detailed test planning, an outline data collection plan and some general criteria pertaining to its expansion and implementation is provided in Appendix D. The outline plan develops in broad terms the nature and relationship of measures of effectiveness, data requirements, methods of collection, and the basic test objectives. It is designed to serve as a framework for detailed collection planning when test design is sufficiently advanced to permit the identification of specific test items, critical events, and details of sequencing and timing of events.

The primary data collection effort in the LOTS test involves relatively simple methods, for example, trained personnel recording times for specific events and entering them on logs, worksheets, checklists or similar records of events. For certain events, it will be desirable to supplement such documentation with photography, both still and motion-picture.

There will also be a requirement for instrumentation during the LOTS test, primarily for constant and accurate recording of environmental conditions. Records of wave and surf conditions, currents, winds, weather, beach conditions and other pertinent environmental data will be required. There will also

be a limited requirement, particularly during certain pre-tests for stress measurements of LOTS systems equipment and relative motion measurements in off-shore check-tests.

TEST RESOURCE REQUIREMENTS

General

Test requirements from a viewpoint of availability of systems components, organizational elements, and operational techniques have been generally addressed in preceding sections of this report. The purpose of this section is to outline, in order of magnitude terms, the support requirements for the DOD elements in the pre-test and main test phases.

The major joint cost, unique to the conduct of the LOTS test are those associated with the per-diem charters of commercial-type ships, and ancillary port charges and cargo handling costs. Accurate predictions of these joint test costs cannot be made until more detailed test plans and schedules have been developed. A rough estimate of such cost, based on the preceding test concepts and estimates of test duration, is approximately $640,000 for the pre-tests and $1,600,000 for the main test[7].

The service support requirements are essentially the resources required to support the joint test force. In general, these will be the costs associated with the operation and maintenance of service equipment and related test activity. Rough estimates of total service support requirements are $260,000 for the pre-test phase and $455,000 for the main test. Certain levels of unit operations are a part of normal service training programs. To the extent training can be integrated to meet the joint test schedules and requirements, these estimated support requirements can be reduced. A more detailed breakout of these support requirements, based on the proposed test concept and illustrative schedules, is contained in Appendix H.

Service Participation

No attempt is made in the test definition to assign specific elements to participate in a particular phase or functional area of the main or pre-tests. It is assumed that the level and nature of service activity will be mutually determined

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7/ Other costs unique to the needs of a joint test, such as test design and planning support, instrumentation, travel and TDY of test directorate staff, data collection, reduction, and analysis are not included in these estimates.

by the Joint Test Director and the services concerned. An estimate of what might constitute a reasonable distribution of test participation and support was made to assist in the development of resource requirements. The estimate can be determined from the illustrative service task organization which is also included in Appendix H.

Ship Availability

The availability of suitable sealift assets will have a major influence on test scheduling and final test design. It is important that ship procurement planning be initiated promptly, monitored closely, and provide for reasonable alternative nominations from industry. The test definition, while optimized in its illustrative descriptions, is considered sufficiently flexible to accommodate some modification as it relates to specific ship types and sequencing.

V. PRE-TEST

SECTION SUMMARY

To verify the feasibility of the main test and minimize the risk of major interruptions or delays, several individual pre-tests have been identified.

The increased size and weight of LOTS system components substantially limit the type ships capable of deploying them to an unimproved operational site. Hence, a major LOTS pre-test requirement is the load and off-load evaluation of LOTS systems components by the four basic commercial ship types mentioned previously.

These system deployment pre-tests will be of short duration (2-4 days) and be conducted in-port and off shore during the second half of FY 1976 and the FY 1976 transition period (FY 76T) in the Hampton Roads area.

Other joint and service pre-tests of an elevated causeway, container handling equipment, a container management system, and main test collection methods are also proposed. A schematic of the pre-tests is depicted in Figure 21.

PURPOSE

In order to verify the feasibility and assure the continuity of a main test in which succeeding activities are largely dependent on the successful accomplishment of each preceeding event, it is desirable to conduct a series of preliminary tests. Through such "check tests" many of the uncertainties associated with the deployment and operation of LOTS system elements can be eliminated without jeopardizing the entire test investment. In the event a pre-test so indicates, modifications can be made in the main test design to permit its conduct; at the same time, necessary changes in existing concepts and/or planning factors can be identified. Certain LOTS operations (such as the handling of breakbulk cargo) are routine and do not require pre-testing. On the other hand, the increased size and weight of LOTS hardware for container handling substantially limit the type ships capable of sealifting these components and discharging them at a marginal port or off-shore. Also several of the technically capable ship systems have never been operationally tested in this role. Hence a major pre-test requirement is the load and off-load evaluation of representative LOTS systems components by breakbulk ship, bargeship and containership. (A limited evaluation of the RO/RO will also be conducted as described below.)

A corollary purpose of pre-testing relates to the safety of personnel and equipment. Although any operation, exercise, or test has its hazards, LOTS operations involve the lifting, handling, and movement of very large, heavy items of equipment and cargo over water, land, and (to a limited extent) through the air. As a result, there are hazards to be identified and eliminated to the extent practical. In addition, time is important but savings must not be

made at the expense of endangering personnel or equipment, or jeopardizing the success of the test. LOTS system components must be evaluated to insure test procedures can be conducted with relative safety.

CONCEPT

General

The concept of pre-testing has its emphasis primarily on LOTS equipment deployment and includes a series of check tests designed to realistically match equipment and ships, validate main test parameters, resolve unanticipated timing or technical problems, and refine main test schedules. Conduct of pre-tests will be subject to several scheduling factors to include ship availability. In addition, pre-tests may be concurrent with some service tests in order to reduce costs. In some cases pre-tests will coincide with on-going service tests (such as the initial operational evaluation of the Navy's elevated causeway). In other instances, pre-testing will be accomplished in conjunction with a service test (for example, conducting an in-port bargeship loading/unloading test of LOTS equipment concurrently with an Army load and stowage test of non-self-deployable aircraft). Finally, some tests may be independent of service tests (an evaluation of environmental data collection devices). Figure 21 illustrates the major pre-tests identified and the areas to be evaluated. Individual pre-tests are described in general terms in subsequent paragraphs. They include examples of LOTS system equipment to be pre-tested by ship type, however, it should be noted that final ship-equipment match-up will be dependent on detailed pre-test design.

Pre-Tests Using Ships

Breakbulk ship. The capability of commercial ships to deploy a LOTS shoreside handling system where adequate fixed facilities are not available is an important consideration. Depending upon the breakbulk ship involved,some equipment, such as the Army's beach crane, may have to be partially disassembled in order to be brought within the weight capacity of the ship's boom. Accordingly, both in-port and off-shore tests are required to realistically evaluate rigging equipment, lifting shackles, potential safety hazards, and securing procedures, as well as to identify other factors that may be associated with lifting this equipment. Equally important is the capability to transport large landing craft to the objective area and unload them. A similar pre-test for the LCU is envisioned using a heavy-lift breakbulk ship.

Non-self-sustaining containership. This type ship could also play a key role in the deployment of LOTS equipment. Deployment capabilities for lighterage, specifically the LACV-30 and the LCM8, are proposed areas of evaluation. The pre-tests will also involve the loading and unloading of a

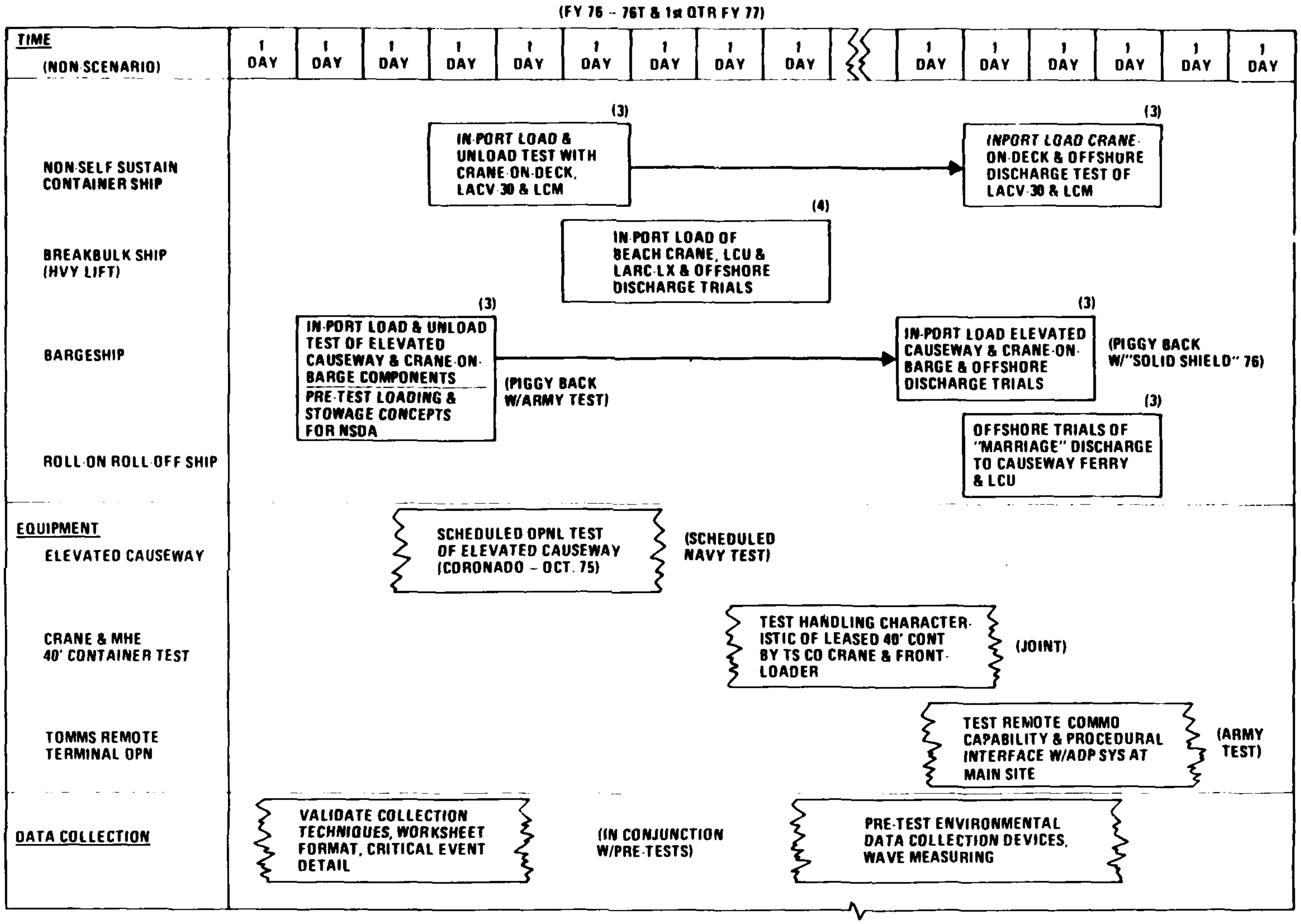

FIGURE 21. LOTS SYSTEM DEPLOYMENT TEST AND OTHER PRE-TESTS

mobile crane (140-ton capacity) with deck reinforcement kit, and the feasibility of loading and unloading of both types of lighterage. After successful in-port tests, a subsequent test in an off-shore environment is proposed.

Bargeship. Potentially, the bargeship is the most versatile merchant ship asset for use in a military operation. It has the capability to deploy causeway sections, lighterage, and shoreside handling equipment. In-port load and off-shore discharge tests, using both a LASH and a SEABEE, are planned to confirm these capabilities. Certain defense features (such as the LASH LCM8 Lift Beam) have never been tested in an operational environment. Candidate LOTS equipment for bargeship deployment testing include the elevated causeway and crane-on-barge. These tests may initially be conducted in conjunction with a planned Army aircraft loading test to minimize costs. A subsequent off-shore test, in conjunction with the SOLID SHIELD 76 joint field exercise, is proposed.

Roll-on/Roll-off ship. The NODEX tests in the early 1960's and several off-shore operations in Vietnam have provided experience in the off-shore discharge of RO/RO type ships in the MSC nucleus fleet. Unfortunately, there is little information available on the results of these tests from which planning factors can be developed, nor is there sufficient information on the interface requirements between the RO/RO ship and lighterage. New merchant RO/RO ships have been introduced which differ in capabilities and may present different problems in off-shore discharge. A key area to be evaluated is the off-shore marriage between the RO/RO and causeway ferries or LCUs. The RO/RO also has a limited potential capability in the deployment of some LOTS equipment. Both these general capabilities should be evaluated by pre-testing.

Equipment Pre-Tests

Elevated causeway. The Navy has had its elevated causeway under development for some time. Originally scheduled for an initial operational evaluation in October 1975, the test has been rescheduled for early 1976. Its availability for subsequent operational tests appears relatively firm. Any joint LOTS pre-test requirements will be identified in the detailed pre-test design.

Forty-foot containers. Current service positions tend to favor limiting LOTS operations to the employment of twenty-foot containers. Yet industry trends toward the use of larger containers may, even in the immediate future, necessitate their use in a LOTS operation. The proposed check test would involve using a limited number of forty-foot containers for handling tests by the new terminal service unit. If its availability permits, the elevated causeway subsystem should also be included. Based on pre-test results, a limited quantity of forty-foot containers could be added to the 450-600 twenty-foot MILVANS planned for use as containership test cargo. The forty-foot containers could be deck loaded on the

containership, used as bargeship barge cargo, loaded on chassis in the RO/RO ship, or preferably in a combination of these options.

TOMMS. To test the employment of the Standard Port System element of the Army's Terminal Operations and Movements Management Subsystem (TOMMS) in a LOTS environment, a capability to remote the system is required. A service pre-test of a mobile remote terminal facility scheduled to be available in FY 76 is proposed to verify its technical capabilities and field operating procedures.

Data Collection

This is another essential function to be accomplished during the pre-test. Pre-test data must be evaluated initially to determine implications for the main test event schedule. During pre-test observations and evaluations, worksheet formats must be refined to better facilitate data collection of all significant events in the deployment, throughput, and distribution and management phases.

Instrumentation such as wind, wave, and other environmental measuring equipment for recording off-shore sea and weather states will be required. The records will be used to assess impacts on pre-test events, particularly those conducted in an off-shore environment. In addition, limited stress measuring equipment may be desirable for certain crane operations. The pre-test instrumentation planning and data readout operations may also be helpful in developing main test instrumentation requirements and procedures.

APPENDIX A

OUTLINE OF LOTS HISTORY

SUMMARY

U. S. military history is replete with examples of requirements to support expeditionary forces without the benefit of adequate ocean terminal facilities. The amphibious and LOTS-type operations of World War II were perhaps the most extensive over-the-shore efforts ever undertaken. As recently as the mid-1960's, the problem had to be met again in Vietnam.

It was, to a large degree, the review of the logistics aspects of that war by a high level defense commission (the Joint Logistics Review Board) that served to focus attention on the new and critical dimensions of LOTS operations and containerization.

EARLY LOTS

Throughout military history there has been a requirement to land military forces over unprepared beaches and to resupply such forces in their campaigns. In early times an army beached its ships in a convenient cove, carried its weapons in hand, and foraged off the countryside. As armies became more sophisticated, artillery heavier and heavier, and with the addition of ammunition and baggage trains, problems began to appear. At the same time ships became larger and could no longer be conveniently beached.

In 1847 General Scott landed 10,000 troops off shore at Vera Cruz. It was nine days before he could lighter sufficient forces ashore to commence operations. In 1891 the U. S. Army landed forces off Daiquiri and Siboney in Cuba. While keeping up with daily commissary requirements, it was two and a half weeks before a three-day reserve of rations could be established ashore. Transportation assets (mules) were pushed over the side to swim ashore..or, as 50 did, out to sea. During World War I the U. S. was able to rely on established ports. However, the allied landing at Gallipoli in 1915 still provides a classic example of how not to conduct an over-the-beach operation.

WORLD WAR II

In World War II, over-the-shore operations played a major role in U. S. campaigns. In the Pacific theater, the ability to support large complex forces over a beach permitted the island hopping strategy. Similarly, it permitted the initiation of a new front in North Africa, the conquest of Sicily, and entry into Europe through Italy, Northern and Southern France. Because of the

numerous operations carried out and the experience gained, near the end of the war the U. S. capability to conduct such operations was tremendous. Planning had become detailed and accurate. Specialized equipment such as LCMs, LCUs, LCTs, LCIs, DUKWs, pontoon piers, beach stabilization equipment, and cranes had not only been developed, but were available in large quantities. Techniques had improved from a line of soldiers handling cargo box-by-box to roll-on/roll-off cargo by the truck load and cranes handling slings and pallet loads. The services had developed highly trained and specialized units to carry out logistics support operations over beaches. This capability peaked with the Normandy landings in June 1944. Despite a severe storm and other problems, massive tonnages rolled ashore at a remarkable rate. The Normandy operation proved that a sizeable invasion force landed on suitable beaches with adequate air, naval, and appropriate logistics support could be maintained regardless of the lack of established port facilities.

POST WAR

In the mid-1950s, the Army Chief of Transportation became concerned about the deterioration of what had come to be known as the Logistics-Over-The-Shore or LOTS capability. Most of the highly trained personnel had left the Army. The available equipment was basically left over from World War II. Among efforts to reconstitute the LOTS capability, a transportation terminal battalion was established to be supported by an engineer port construction company. A series of New Off-Shore Discharge Exercises (NODEX's) were conducted to keep alive existing techniques, to provide a nucleus of skilled personnel, and to test new equipment and new techniques. NODEX's pioneered efforts on use of Delong piers and various types of pontoon piers and quays. The exercises tested means of discharging CONEX containers (the first truly containerized cargo) and moving them to and across the beach, and experimented with various means of stabilizing and organizing beaches. As the RO/RO ship USNS Comet entered the Military Sea Transport Service (now MSC) inventory, means of discharging RO/RO ships over the beach became an item of major interest. The NODEX's ended in the early 1960's and the terminal battalion was deactivated. However, the emphasis placed on LOTS by the Army subsequently paid off in Vietnam.

VIETNAM

Vietnam posed a near-classic situation requiring LOTS operations. South Vietnam was a country with basically only two small ports, Saigon and Danang. These had been developed to handle small merchantmen and native craft. Berthing facilities were extremely limited. In 1965 when the U. S. buildup started, it was evident that port throughput would be the logistical choke point. The immediate means of establishing some relief was to set up large LOTS operations. This was done at Vung Tau, Qui Nhon, Cam Ranh and Cat Lai.

Delong Piers were towed to Vietnam and eventually emplaced at Danang, Qui Nhon, Phan Rang, Nha Trang, Cam Ranh, and Vung Tau, making these locations true ports. Thus, the need for a massive LOTS operation ceased. However, because of the necessity for keeping ammunition discharge away from populous areas, Cat Lai continued in-the-stream discharge until the end of U. S. involvement.

In 1967, plans were completed and a contract let to initiate commercial container service to Vietnam. This posed several new problems. First, of the three major ports of entry -- Danang, Cam Ranh, and Saigon -- only Cam Ranh could accept the large trans-Pacific containerships. Second, the ports lacked sufficient hard-stand areas necessary for marshalling yards for containers and trailer chassis. Third, there were no container cranes available to handle non-self-sustaining ships. Ancillary to this problem was the difficulty of tying up a general cargo berth with a container crane while the greatest quantity of supplies were still arriving on general cargo ships.

To solve these problems, hard-stand and trailer maintenance facilities were established at each of the three ports. A shuttle operation was established at Cam Ranh where the large non-self-sustaining containerships were discharged by means of an emplaced container crane. Smaller self-sustaining ships delivered containers from there to Saigon and Danang.

This shift in trans-Pacific shipping service permitted the replacement of 18 breakbulk (Victory) ships with three containerships. Savings amounted initially to \$8 per measurement ton as a result and increased to \$11 a measurement ton as up to seven non-self-sustaining containerships were later introduced into the service. MSC estimated that because of reduced port handling times, surface shipped cargo which went via containerships took only half as long as breakbulk cargo. As of March 1972 (before the draw-down of U.S. forces) approximately 6,434,000 measurement tons of cargo had been shipped to Vietnam in containers during the $4\frac{1}{2}$ years of container service. This represented 42 percent of all cargo (less ammunition).

JOINT LOGISTICS REVIEW BOARD

In 1970 DOD sponsored a high-level study group to assess logistic support in the Vietnam era. The results of that study provided focus on the technological revolution taking place. In brief, the Joint Logistics Review Board (JLRB) found a serious void in the military services' capabilities to conduct LOTS type operations, with the trend toward non-self-sustaining containerships and their requirements for fixed port facilities. At the same time the benefits of containerization were recognized and a strong recommendation was forwarded to exploit the benefits of this new technology. (Comments on the effects of the JLRB study will be found in the following appendix on previous LOTS evaluations.)

APPENDIX B

PREVIOUS LOTS/LOTS RELATED EVALUATIONS

SUMMARY

The early 1970's were marked by a variety of service efforts, both individual and collective, to evaluate the LOTS-Container problem in depth, and to find suitable means to adapt to its evolving parameters.

A variety of conceptual studies have been accomplished, but efforts to obtain hard data on LOTS systems capability have been relatively limited. This is attributable to both the state of development of LOTS systems elements, as well as the high cost inherent in using chartered ships for realistic testing.

The two major joint field evaluations conducted in the past (Offshore Discharge of Containership - OSDOC I and II) have been primarily development-oriented. While each served a useful purpose in the system acquisition process, neither met the requirements of an operational test in terms of approach, test conditions, adequacy of measurements, scenario constraints, or duration.

GENERAL

Although the technological implications for LOTS created by the revolution in the shipping and transportation industries were recognized within DOD as early as the mid-1960's, it wasn't until the convening of the Joint Logistics Review Board and subsequent publication of its findings in 1970 that the containerization problem received full attention. The most widely distributed study relating to advanced cargo throughput methods, such as containers, barges and use of RO/RO ships, is Monograph 7, Containerization to the JLRB report on Logistic Support in the Vietnam Era. This monograph documents the use, potential, and implications of the new transportation systems and recommends their exploitation by the Armed Forces. Particular emphasis is placed on the role of containers in Vietnam and DOD shortcomings in their use. Ultimately, this report led to the joint Off-Shore-Discharge-of Containership (OSDOC I and II) exercises, as well as numerous developmental projects within the services.

OSDOC I

OSDOC I, which took place over a five-day period in December 1970, was an outgrowth of the JLRB report and was the first military LOTS experiment to employ a containership. The exercise, jointly sponsored by the Army and Navy, was intended as an examination of the impact of offloading and transporting containers in a field environment. In effect, OSDOC I was an initial fact-finding attempt to acquire information such as constraints imposed on container throughput by weather, sea states, beach conditions, and equipment limitations; discharge and handling rates in the ship-to-shore movement; and the sensitivities of ship unloading by helicopter. Specifically, the objectives were to identify modifications required for lighters, handling equipment, chassis, helicopters, and cargo gear. The test confirmed suspected voids in the ability

to handle containers over the beach and it served to focus attention on the problem.

OSDOC II

OSDOC II, conducted in October 1972, was the first joint test to employ a non-self-sustaining containership in a LOTS environment. It was a more complex exercise than OSDOC I. Using considerable commercially leased and contractor operated equipment, OSDOC II was originally intended to test 13 different systems to determine a system discharge capability expressed in containers per hour. This did not turn out to be an attainable objective and was subsequently modified to test only the components of the 13 systems nonsequentially. Interactions between the system components were not measured. The test did provide rough estimates on the system discharge capability and some conceptual basis of evaluation. Test results in the OSDOC II final report were acknowledged to be of limited statistical value because the magnitude of error was unknown. Useful information was obtained with respect to container movement management and personnel requirements. Container unstuffing and distribution were not tested.

HELICOPTER SHIP UNLOADING DEMONSTRATION

One commercial test of unloading a containership off-shore has been recorded. In January, 1967, in response to an MSC proposal, American Export Isbrantsen Lines (AEIL) in conjunction with Sikorsky Aircraft demonstrated a system designed to carry containers ashore by helicopter. The object of the test was to discharge 45 loaded containers (maximum weight less than 10 short tons) from a self-sustaining containership and transport them five miles inland. Before foul weather aborted the test, 31 containers were trans-shipped ashore[1/].

SPANS

The Sealift Procurement and National Security (SPANS) Study was jointly sponsored by the Maritime Administration and the Department of Defense. It is a series of substudies published between 1971 and 1972 dealing with: Defense shipping requirements; the capability of the U. S. flag fleet to meet military sealift requirements in peace and war; the relationship of Defense shipping requirements to commercial traffic patterns and the development of a healthy and growing merchant marine; methods of procuring commercial ship space for Defense purposes; and the problems, shortfalls, and opportunities in military sealift operations resultant from the evolutionary conversion of the U. S. Merchant Marine from self-sustaining breakbulk ships to specialized highly-productive ships. SPANS is a comprehensive survey of ships and ship systems but addresses only one aspect of throughput and LOTS operations. The study

1/ American Export Isbrantsen Airlift Corporation, Containership/Helicopter Delivery System Demonstrated on January 27, 1967, 1967.

set the stage for other studies by helping to identify shipping problems. It is a widely referenced source in this area.

NAVY EFFORTS

The Navy container/LOTS-related efforts started in the late 1960's. They came under a project called Expeditionary Logistic Facility (ELF) later redesignated the Container Offshore Transfer System (COTS). These efforts were intended to develop prototype equipment, perform critical experiments, and accumulate hard data for ship-to-shore cargo movement. Essentially COTS is aimed at maximum use of existing military and commercial assets, simplicity, and use of modular pre-engineered concepts such as the pontoon causeway. The use of mobile cranes on non-self-sustaining containerships (tested during OSDOC II) was a concept pursued initially. Other LOTS-related projects under COTS currently include the elevated causeway, the self-propelled causeway, crane system evaluations, and methodologies for stuffing/stripping containers. In addition, under the broad aegis of COTS, the mooring and unloading of barges offshore has been tested. A series of technical papers and equipment-oriented studies have been published to disseminate results of tests, evaluations, concepts, and operating procedures. In this fashion COTS is a continuing developmental effort broadly directed toward ship unloading, ship-to-shore movement, cargo management, and use of barge ships.

THE ARMY IN THE FIELD CONTAINER SYSTEM STUDY (AFCSS)

The Army Training and Doctrine Command (formerly Combat Developments Command) in March 1974 completed a comprehensive study entitled The Army in the Field Container Systems Study. The purpose of the study is to design a container distribution system for a 17-division force in a theater of operations. The concept provides that containerization will be utilized to its greatest potential to deliver supplies directly and expeditiously to the lowest echelon practicable. Distribution patterns and the feasibility of handling containers of various sizes at general support and direct support echelons were determined. The principal substudies of AFCSS identified MHE, transport equipment, a family of containers, and organizational changes needed to support container operations. The study further concludes that supply and transportation organizations must be capable of handling both breakbulk cargo and containers concurrently, including 40-foot containers. On the other hand, it also concludes that LOTS operations should be limited to containers no larger than 20 feet. The AFCSS study is currently being reviewed at Headquarters, Department of the Army.

TRANS-HYDRO[2/]

In February, 1975 the Department of the Army officially approved the

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2/ Trans-Hydro craft are any craft capable of crossing a water barrier, including displacement hull vessels and amphibians, surface effect ships, air cushion vehicles, hydrofoils, and aircraft.

results of a project entitled U. S. Army Trans-Hydro Craft Study 1975-1985 (short title: Trans-Hydro). Data for the study included OSDOC II experience. The problem addressed by the study was that the Army trans-hydro craft fleet was technologically obsolete and could not adequately support LOTS operations involving containers. In addition, it was felt that current Army craft inhibit fast turn-around of shipping thereby reducing ship productivity. Besides examining numerous candidate craft, the study looked at craft shoreside unloading. Finally, the study briefly addressed the Army "fleet" capability to discharge non-self-sustaining containerships but deferred selection of proposed alternatives to joint development study. One of the outcomes of the study was the development and documentation of a LOTS Simulation Model, a tool employed to evaluate performance of various trans-hydro craft under varying assumptions. The resultant conclusions as modified and/or approved by the Army have led to the purchase of two pre-production air cushion vehicles (the LACV-30) and the proposed establishment of a provisional LACV-30 unit, retention of specific landing craft and amphibians, and establishment of beach materials handling equipment capabilities.

MARINE CORPS CONTAINER STUDY

The Marine Corps, in December 1974.released for staffing its major study on containerization, entitled Containerization Requirements for the Fleet Marine Force (1973-1982). The study does not recommend the use of 20-foot containers in the assault echelon (composed entirely of amphibious ships) but does foresee a valid requirement for containers in its assault follow-on echelon and resupply phases. Both of these latter phases of the amphibious operation have nearly the same characteristics as a LOTS operation with the possible exception of distribution from containers. Conceivably, 20-foot containers could be introduced three to five days after the initial assault to augment combat service support resources or to resupply front line forces. The procedures described in the study envision a bare beach situation with development of a full container capability commencing as soon as the tactical situation permits. Equipment and personnel required, including an elevated causeway, are embarked aboard amphibious ships, making the deployment of handling equipment relatively simple. The study recognizes the possibility of 35- and 40-foot containers being employed and has recommended a minimal equipment capability (minimal to reduce ship space requirements for deployment) to handle them. At the same time, it discourages use of 35- and 40-foot containers in order to keep at a minimum new equipment that would be needed to optimally handle and transport the heavier loads. The Marine Corps study, which looks closely at its unique situation with respect to amphibious ships, also addresses the use of modular and special containers, stuffing/stripping requirements, and handling and equipment requirements.

MHE STUDY

The Army, in response to a requirement for a re-evaluation of supply handling and equipment requirements, conducted a study entitled The Field Materials Handling Equipment Family (MHE Study). The purpose was to determine an efficient, integrated system of MHE to support the Army in the field employing containers and direct delivery concepts. Completed in October 1971, the study recommended a family of field MHE which provided a capability for use of containers. Although the recommendations as offered in the study were modified upon approval, the intent of the study of providing a family of MHE for container handling remained intact.

DOD PROJECT MANAGER

Also pursuant to the findings and recommendations of the JLRB, a charter was granted in June 1971 establishing a DOD Project Manager for Surface Container-Supported Distribution Systems Development (DODPM). His function was to develop related standard equipment, policies, and procedures for the military services and the Defense Supply Agency (DSA). For the past four years the DODPM operated under a project master plan which provided an overview of surface container-supported distribution developments. The charter for the DODPM expires in June 1975. By that time three definition papers dealing with offshore containership discharge, covering the areas of ship unloading, lighterage, and shoreside handling subsystems are expected to be published.

BARTAP CONFERENCES

MSC has sponsored two joint service conferences dealing with "Barge Transportation Appraisal Program (BARTAP)". These conferences have been directed toward the exchange of views on concepts of employment for existing LASH and SEABEE barges in an unimproved environment and for dissemination of results of developmental tests involving barges. Most of the barge testing to date has been accomplished by the Naval Facilities Engineering Command, although recently, operational commands in the Navy and Marine Corps have also been conducting their own tests. The specific areas of interest in these on-going studies, tests, and evaluations have centered on employment concepts, unloading, handling and tug support, compatibility of cargo, and the mooring of barges. Periodically the results of these efforts are published in field and laboratory reports. The BARTAP conferences have been instrumental in providing a focal point for review, problem identification, recommendations, and direction for further efforts.

MSNAP

In 1974, MARAD, in conjunction with the Navy, issued a Request for Proposals with respect to a research program entitled Merchant Ship Navy Auxiliary Plan (MSNAP). This program is being established to provide basic technical data to determine the feasibility and desirability of constructing, installing, and operating cargo handling and transfer systems aboard commercial ships. The intention is to provide merchant ships with the temporary capability for naval underway replenishment and for ship unloading in underdeveloped ports through a modular system of portable equipment and related operating procedures. The mutual MARAD and Navy interest is directed at jointly laying the technical framework for later independent development and utilization of such cargo handling/transfer/off-loading systems.

NDRF

One area receiving a considerable amount of study is the National Defense Reserve Fleet (NDRF), which has long been considered the back-up for today's U. S. Merchant Marine. In terms of dry cargo vessels (military auxiliary vessels are excluded) there are 176 breakbulk vessels at various locations in the U. S. The characteristics of these vessels are summarized below.

GENERAL OPERATIONAL CHARACTERISTICS
NDRF DRY CARGO VESSELS 3/

Construction Year	No. Ships	Speed	Maximum Boom Capacity (STON)	Average Dead Weight Tonnage
1942	5	11	50	10,700
1943	22	10-14	50	10,000
1944	39 4/	11-16.5	30-92	11,000
1945	109	15.5-16.5	50	10,700
1965	1	20	60	14,700
NDRF TOTAL	176	14.6KTs(Avg)	50(Avg)	10,700 (Avg)

Of the 176 dry cargo ships in the NDRF, 130 are earmarked for MSC use into the 1980's. This fleet's capability is considered questionable by some DOD planners. Planning estimates for activation of a ship currently are said to be 30 days once the ship gets into a shipyard and work is begun. Upon completion it would be turned over to a commercial operator who crews the ship. Costs for this work vary subject to the ship, priority, and level of work to be accomplished. This program and NDRF policies are under study for possible revisions, including a proposed capability to activate a small number of ships in about one-third the current fleet's estimated required activation time.

3/ Extracted from the Military Sealift Command Publication, SHIP REGISTER, MSC P504, January 1975.

4/ Includes containership conversions.

OTHER STUDIES

There are a number of studies relating to the evolution, description, and impact of containerization and the use of bargeships and RO/RO ships which pertain to LOTS and were referred to in this study. For brevity however, they are not discussed in this section. A more complete listing is contained in the bibliographic section of this report.

APPENDIX C

MEASURES OF EFFECTIVENESS

SUMMARY

This appendix describes the kinds of measures of effectiveness that are expected to be useful in the proposed LOTS tests. The basic measures are a) deployment times and b) cargo throughput capabilities; these measures are applied to specific systems and subsystems, or to specific organizations such as a terminal service company, and may also be combined with resource use. (An example of the last is tons per manhour). Two categories of measures of effectiveness are tabulated in the appendix: ones that use only information gathered in the test itself, and ones that may also use additional information. An example of the second would be time enroute from a U. S. port to a specific objective area, clearly dependent on information on distance and ship speed that is not collected during the test.

The appendix discusses combined measures of effectiveness, and gives two examples that might be useful to a military planner. It also discusses the problems of evaluating typical delays, and the problem in the possible use of incomplete or otherwise non-typical systems.

BASIS FOR MEASURES OF EFFECTIVENESS

A LOTS operation is undertaken only in contingencies when forces must be supplied and fixed facilities cannot be used. All uses of LOTS are characterized by urgency, and almost all by the need for self-sufficiency.

The fundamental effectiveness of a LOTS system is thus its capability to provide timely and adequate support to combat forces. More specifically, the following primary requirements are placed on the system and form the basis for quantified measures of effectiveness in the proposed test of LOTS capabilities:

a. The system must be deployable within some number of days compatible with military requirements, in maritime ships that will be available in an emergency;

b. The system must have a throughput capability sufficient to provide the required level of support to the force ashore;

c. The system must be able to adapt to, and move cargo in, a wide range of environmental and operating conditions.

These requirements describe what the system must do. In addition, it is desirable that what is done, be done efficiently. The deployment, throughput, and operating capabilities must be attainable with reasonable expenditures of resources. Some of the measures of effectiveness (MOE) discussed in this appendix include quantitative consideration of the resources used.1/

Two general measures of effectiveness derivable from a, b, and c are basic:

- Deployment times for specified capabilities and circumstances, and
- Cargo throughput, in containers per hour or tons per hour, under specified operating conditions.

In application, these general measures are further defined so as to apply to the specific systems or subsystems under test, or to specific organizational entities, such as a terminal service company. A number of MOEs in this category will be found in Figure C-1. This listing shows MOEs that will be used in the proposed test and which use only data obtained directly from the tests. Certain other pertinent measures of effectiveness, listed in Figure C-2, include use of data and information from sources other than the test.

In general, the measures of effectiveness on both lists can be applied on what might be termed a hierarchial basis. That is, they can be applied to either a specified item of equipment, or to the whole set of equipment. They can apply to part of the operation, or several consecutive parts can be combined. Note, however, that combining some of the measures may not be direct. If, for example, it is possible to do two operations concurrently, the times for two may simply be the time for the longer one.

1/ A distinction might be made between measurements whose purpose is to confirm or establish a planning factor for the capability of a unit or a piece of equipment, and the classic measure of effectiveness whose purpose is to compare the capabilities of alternative ways of performing a task. Measures of effectiveness often, but not always, include explicitly the concept of resource use, e.g. tons moved per man-hour. For present purposes, there seems to be no reason for confining the phrase "measure of effectiveness" to comparative uses.

EXAMPLES OF MEASURES OF EFFECTIVENESS THAT CAN BE FOUND DIRECTLY FROM DATA COLLECTED IN PROPOSED TEST

Test Purpose	Specific Measure of Effectiveness
LOTS EQUIPMENT DEPLOYMENT OPERATIONS	
Confirm operational capability for far-shore part of system deployment	Hours required to start initial flow of cargo to shore once ship has anchored.
Confirm operational capability for unloading of individual major equipment items for LOTS. Examples: cranes; landing craft; LACV-30; causeway ferry, elevated causeway.	Hours required to unload various individual items of equipment and make them ready for use in LOTS unloading.
CARGO THROUGHPUT	
Confirm overall capability of Transportation Terminal Battalion -- two Company strength in proposed test-- to discharge, marshal, document, and manage operational throughput.	Number of containers and tons of general cargo sustained throughput per 20-hour day.
Comparisons of systems.	Overall containers per day for different throughput systems, and man-hours expended per container moved ashore, for same systems.
Determine throughput capabilities for various equipment sub-systems	For lighters, "working rates" in containers moved per day. For cranes, container lifts per day. (For either, with breakbulk cargo, tons per day.)
INTERFACE WITH DISTRIBUTION OPERATIONS	
Confirm shoreline-to-marshalling-area movement capability of system.	Movement capability in containers per 20-hour day and tons per day.
Confirm capability to maintain records identifying containers and breakbulk cargoes, and sorting them for appropriate destinations.	Percent of errors in identity of cargo and in arrival at alternate locations during inshore movements.

FIGURE C.1. DIRECT MEASURES OF EFFECTIVENESS

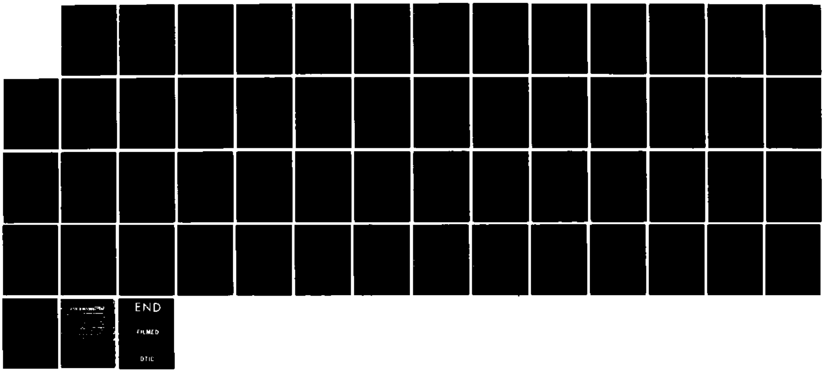
EXAMPLES OF MEASURES OF EFFECTIVENESS THAT USE INFORMATION IN ADDITION TO THAT GATHERED IN THE MAIN LOTS TEST

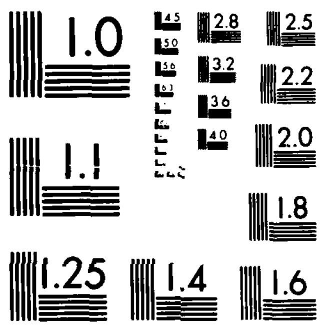
LOTS Evaluation Purpose	Specific Measure of Effectiveness
DEPLOYMENT OF LOTS EQUIPMENT	
Ship availability for prompt outloading of equipment	Mean number of days after a decision that emergency deployment is needed that successive ships capable of outloading LOTS equipment would be available in specified ports.
Time for equipment to be available for shipment	Time required for equipment that is to be used in LOTS unloading operations to be made available and be transported to ship side for loading onto ship.
Evaluation of "match" between ship and LOTS equipment.	Lists of quantities and sizes of LOTS equipment of a typical Army Terminal Battalion, together with the capabilities of the ship (or ship class) to (a) lift, (b) provide space for (on deck or otherwise). Specific measures of effectiveness to be developed heuristically. (See text)
Loading times for equipment; man-hours for loading equipment	For each item (and for suitable combinations of items into sets), the mean time from delivery on the dock to final tie down aboard the ship.
Ship time enroute to objective area (for ships with LOTS equipment)	Average steaming times for selected vessels from U.S. ports to particular strategic areas.

FIGURE C.2. MEASURES OF EFFECTIVENESS THAT USE INFORMATION IN ADDITION TO THAT GATHERED IN TEST

AD-A149 207 SURVIVABILITY AND DEFINITION OF A JOINT LOGISTICS-OVER-THE-SHORE (LOTS) OPERATIONAL TEST(U) ORI INC ROCKVILLE MD C COLLINS ET AL. 30 APR 75 ORI-TR-913 2/2

UNCLASSIFIED MDA903-75-C-0016 F/G 15/5 NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963 A

MOVEMENT OF CARGO TO OBJECTIVE AREA	
Ship availability to outload cargo	Mean number of days after a decision to respond to an emergency requirement that the first, second, and nth ships capable of carrying container cargo would be available in specified ports.
Time enroute	Mean times for various ships to arrive at objective area with cargo, from leaving dock to dropping anchor.
Unloading time for typical ship	Time required to prepare for unloading and to unload ship. For some analyses adjustment can be made to test results to account for size of test ship relative to "typical" ship.
Time for outloading retrograde cargo	Any additional time that would be taken for retrograde cargo over and above time that includes concurrent unloading. May be calculable from test results, assuming size of ship is known.

CARGO THROUGHPUT

Note: Cargo throughput MOEs generally covered in Figure C-1. However, to find "typical" values, additional data may need to be used, e.g., provision for greater or lesser proportion of different sea states than actually encountered in test.

INTERFACE WITH DISTRIBUTION OPERATIONS

Note: Cargo throughput MOEs generally covered in Figure C-1. However, to find "typical" values, additional data may need to be used, e.g., provision for greater or less cargo storage areas than actually encountered in test. "Typical" values of usable beach areas, gradients, and the like in various strategic areas are obtainable, and could be used to adjust test results.

FIGURE C.2 (Continued)

Combining Measures of Effectiveness

One problem area forseen is that certain of the subsystems will have inherent (and appropriate) delays in order to make the system as a whole more effective. Specifically, the ship unloading subsystem is critical with respect to throughput. The lighterage subsystem will be set up to provide a queue in order that the crane will be supplied with lighters in spite of variances in crane cycle times. It will be necessary, then, in calculating measures of effectiveness for the lighterage, to take this waiting time into proper account.

MOEs that combine other MOEs. In a cost-effectiveness approach to decisions about LOTS operations, it may prove desirable to combine measures of effectiveness in a chain of events. A hypothetical example of one measure of effectiveness that would combine several less comprehensive ones would be:

> The probability that the first 1,000 (or some other required quantity) cargo containers can be landed and moved to a temporary staging area within x days after the decision is made to act on the emergency.

Clearly, such a measure would combine the equipment deployment and the cargo movement measures, as well as combining the chain beginning with obtaining the ships and proceeding through loading, moving to the objective area, unloading and assembling the equipment, and using it sufficiently to establish an on-going throughput capability. Proper numerical evaluation would include the probabilities of sea-states of particular values in the selected objective areas. This MOE, if on the basis of only a single value for x (e.g., the number of elapsed days), would be considerably less helpful than for a series of values. In addition, the steaming distance for the ships to selected objective areas would have a strong influence, and would also need to be considered on a parametric basis (i.e. several values would be used in the calculation). Such a measure of effectiveness would be of greater usefulness to a military planner than separate individual measures useful to operators.

A combined measure of effectiveness that would be useful to a planner for evaluating deployment effectiveness is more difficult to set up. For example, a measure might be desired that would help in evaluating capabilities of ships (or ship types) for deployment of LOTS equipment. Various factors are pertinent for such a measure:

1. The average time that would be required for ship to become available in an emergency;
2. The quantities of such ships available for emergencies;
3. Ship loading times and sailing speed;
4. The organic capability of the ship to unload the LOTS equipment at the objective area. (For example, Lift off or launching for lighters, or roll off for other equipment, from RO/RO ships);
5. Space available for transport of heavy or outsized equipment (e.g. deck space for heavy lifts);
6. The equipment (and equipment mix) needed for the projected LOTS operation: how many cranes, what lighters and MHE, etc.

The first three could be combined into a probability of arrival at the objective area in x days, in a way similar to the measure discussed above. The last three cannot be combined in a simple fashion. It may be possible to find what percentage of the needed mix of equipment for a specified operation could be carried and off-loaded by a particular ship. The product of this percentage and the probability set up from the first three would be an example of a combined measure of effectiveness that could be useful in comparing ship capabilities.

BASIS FOR ANALYSES

Although it appears probable that its numerical value will be small, one fundamental of the way it is planned to run the test has an impact upon the analysis that is important to understand. The test is intended to measure actual overall operating capabilities. The implication is that the test results to be reported will include time for normal delays, personnel fatigue or misjudgments, re-allocation of personnel and equipment to achieve balance in operations, and similar management and operating considerations occurring in a real life situation. In effect, the test director will expect the operation to be carried out by the unit personnel responsible for making their own decisions. The decisions will be treated as being typical of the operation being observed, "warts and all". Such a test is in contrast to one whose primary purpose is to find data for specific equipment development, or for comparisons of detailed methods. For such development or comparison tests, some or most delays would presumably be excluded, or made equal in the analyses for systems being compared.[2/]

2/ The potential for insight into the problem from an overall test that records complete data including delays and errors has been pointed out for post-flight analyses of multiple air combat tests.

Analysis of the planned test for validation of planning factors, then, makes a basic assumption. Whatever inefficiencies, delays, or interruptions occur can either (a) be considered as typical of the events that would happen in real life for the same or other causes, or (b) can be eliminated or otherwise re-evaluated. Either way the assumption is taken, there is an element of subjectivity[3/] involved. No problems are anticipated in establishing criteria for making decisions on such matters. By the nature of the test, such decisions are necessary.

Use of Non-Typical Equipment or Conditions

At the same time two other aspects of the test procedure also have impacts on the overall aspects of the analysis of results. Test plans may, for some of the systems tested, (a) use incomplete organizational units or incomplete subsystems and (b) require certain adjustments if the ship, equipment, or setting is not in some sense "typical". Either could result from a need for test economy, or from a problem of equipment availability. An example is that only a section of LACV-30s are scheduled to be available (i.e. two) rather than a full company. LACV-30 test results will have to be extrapolated to show full-system results. Examples of non-typical equipment or setting might be:

- Use of a non-typically large or small containership
- Use of a ship-to-shore distance that is non-typical
- Occurrence of non-typical wave conditions during the test (either flat calms or unusually high waves.)

In order to make adjustments to the test results to have them apply as being typical there must be agreement as to what the criteria are. Such criteria will be established as part of the final plan of analysis.

3/ Even if there were to be no delays or inefficiencies uncovered in the test, the test result user would seemingly have to decide (subjectively) whether a typical operation would in fact include them.

APPENDIX D

DATA COLLECTION

SUMMARY

This appendix outlines the principal data to be collected in the main test, by phases, and the methods to be used. The data is largely the elapsed time for the various events, as for example the time for offloading specific items of LOTS equipment, or the times required for unloading containers from the ship into lighters. Component parts of each event are to be recorded, as an assistance in analysis. The times will be recorded from continuously-running watches, in order to insure that times for delays are fully included. Records will also be kept of wave, weather, and other environmental factors.

DATA TO BE COLLECTED

Figure D-1 outlines the principal data to be collected. The information in the table is divided into phases, and is in approximately the order in which the test will proceed. The principal measurement made for most of the listed data is time. A suitable record of what happened during a given time interval is of course an indispensible part of the data.

METHODS OF DATA COLLECTION

The basic data to be collected is the time the various events in the operational test occur. The record of what has happened during an interval of time is just as important as the times that were recorded. Descriptions of reasons for delays and waiting times can provide insights on analysis of the data. For repetitive cycles, such as crane operations, the cycle should be broken into parts. In previous studies it has been possible to discuss differences between cycle times for loading from ships into different lighter types on the basis that (1) a substantial fraction of the time the load was in the hold being made fast, or (2) was being hoisted and not even in the vicinity of the lighter. These parts of the hook cycle, then, were unchanged when different lighters were loaded. Only the measured parts of the cycle when the time was influenced by the lighter configuration was considered "lighter sensitive," and comparisons between lighters were substantially clarified.

Observers will record events on log-format record sheets -- ones that show the time of day and describe the event that took place. Observers will be trained to record the particular parts of the event used as start and stop

MEASUREMENT	DATA REQUIRED	DATA COLLECTION METHOD	TEST OBJECTIVE APPLICATION (VALIDATE/REFINE)
PHASE 1 A – DEPLOYMENT – ASSEMBLY OF DEPLOYMENT SHIPPING			
1. TIME REQUIRED FROM DECISION TO DEPLOY UNTIL ARRIVAL OF SHIPS IN PORT & READY FOR OUT LOADING	D-DAY SHIP AVAILABILITY DATA (TYPE, LOCATION, SPEED, CARGO ABOARD & DESTINATION)	SHIP INFORMATION SYSTEM MODEL (SIS) PROPOSED LOTS SYSTEM SIMULATION MODEL	OPNL TECHNIQUES & PLANNING FACTORS
PHASE 1 B – DEPLOYMENT – LOTS SUB-SYSTEM EQUIPMENT OUTLOADING			
1. TIME REQUIRED FOR LOADING & SECURING EACH MAJOR LOTS SYSTEM ITEM FROM ARRIVAL AT SHIPSIDE TO FINAL TIE-DOWN	RECORD OF EVENTS	WORKSHEET/LOG/STILL PHOTOS	PLANNING FACTORS
2. MANPOWER REQUIREMENTS TO ACCOMPLISH TASK FOR EACH TEST ITEM LOADED	RECORD OF TIME OF CRITICAL EVENTS – REASONS FOR DELAY, IF ANY RECORD OF EVENTS	WORKSHEET/LOG/MOVIE PHOTO	FORCE STRUCTURE
3. TIME FOR ACCEPTANCE OF SECURITY OF LOAD BY SHIPS MASTER	RECORD OF EVENTS	WORKSHEET/LOG SHIPS LOG/PHOTO	
PHASE 1 C – DEPLOYMENT – MOVEMENT TO OPERATIONAL AREA			
	LIMITED PHYSICAL MOVEMENT – TOTAL VOYAGE TIME SIMULATED NO SPECIAL TEST OBJECTIVES INVOLVED – HOWEVER OBSERVERS WOULD NOTE ANY SIGNIFICANT EVENTS ENROUTE, e.g. – SHIFTING OF LOADS		NONE
PHASE 1 D – DEPLOYMENT – LOTS SUB-SYSTEM EQUIPMENT OFF LOADING			
1. TIME REQUIRED FOR OFFLOADING FROM ARRIVAL OF SHIP IN OBJ. AREA TO FINAL POSITIONING OF EQUIP. FOR DISCHARGE OPERATION	RECORD OF TIME OF DETAILED EVENTS – REASONS FOR DELAY, IF ANY	WORKSHEET/LOG/MOVIE PHOTOS	OPNL TECHNIQUES PLANNING FACTORS
2. TIME REQUIRED SYSTEM EQUIPMENT TO BE FULLY OPERATIONAL AFTER OFF-LOADING	RECORD OF TIME FOR EQUIPMENT PREPARATION, DELAYS/ABORTS FROM DAMAGE	WORKSHEET/LOG	OPNL TECHNIQUES
3. MANPOWER REQUIRED TO ACCOMPLISH EACH TASK & TOTAL REQUIREMENT	RECORD OF EVENTS WEATHER & SEA CONDITIONS AT TIME OF OFFLOAD	WORKSHEET/LOG ENVIRONMENTAL MEASURING DEVICES	FORCE STRUCTURE

FIGURE D.1 DATA COLLECTION OUTLINE

MEASUREMENT TO BE MADE	DATA REQUIRED	DATA COLLECTION METHOD	TEST OBJECTIVE APPLICATION (VALIDATE/REFINE)
PHASE II A – OFFSHORE DISCHARGE OF SHIPS CARGO			
NSS CONTAINER SHIP	RECORD OF EVENTS	WORKSHEET/LOG	
	WEATHER & SEA CONDITIONS (PERIODIC BASIS) – RELATIVE SHIP MOTION		
1. DETAILED TIMES OF EACH CONTAINER DRAFT LIFT FROM INITIATION OF LIFT TO PLACEMENT ABOARD LIGHTER [1]	RECORD OF TIME OF EACH SEGMENT OF DISCHARGE EVENT	WORKSHEET/LOG	OPNL TECHNIQUES PLANNING FACTORS EQUIPMENT REQUIREMENTS
2. CARGO DISCHARGED OVER GIVEN PERIOD OF TIME (NO. & TYPE LIFTS & WEIGHT)	REASON FOR DELAYS, IF ANY	WORKSHEET/LOG	
3. MANPOWER REQUIRED TO ACCOMPLISH CARGO DISCHARGE FOR EACH SUB-SYSTEM/TIME PERIOD	LOCATION OF EACH CARGO DRAFT ABOARD SHIP	SHIP CARGO STOWAGE PLAN/LOG	DITTO
	TYPE OF LIGHTER INTO WHICH CARGO DISCHARGED	WORKSHEET/LOG	FORCE STRUCTURE
	WEIGHT OF EACH CONTAINER		
BB – SAME AS NSS CONTAINER SHIP	RECORD OF EVENTS WEATHER & SEA CONDITIONS RECORD OF TIME SEGMENTS	WORKSHEET/LOG	PLANNING FACTORS
BS – TIMES FOR UNLOADING BARGE FROM SHIP AND FOR RECOVERING BARGE	RECORD OF EVENTS	WORKSHEET/LOG	PLANNING FACTORS
RO/RO			
1. TIME REQUIRED FOR MARRIAGE OF RO/RO SHIP WITH EA. TYPE LIGHTER	RECORD OF EVENTS		OPERATIONAL TECHNIQUES PLANNING FACTORS EQUIPMENT REQUIREMENTS
	WEATHER & SEA CONDITIONS		
2. TIME REQUIRED TO TRANSFER EA. TYPE VEHICULAR LOAD TO EA. TYPE LIGHTER	RECORD OF TIME FOR EACH TYPE ITEM DISCHARGED		

[1] – FOR HELICOPTER DISCHARGE, LIFT CYCLE IS COMPLETED WITH BEGINNING OF FORWARD MOVEMENT OF AIRCRAFT AFTER CLEARING CONTAINER FROM CELL.

DATA COLLECTION OUTLINE (Continued)

MEASUREMENT	DATA REQUIRED	DATA COLLECTION METHOD	TEST OBJECTIVE APPLICATION (VALIDATE/REFINE)
PHASE II B – SHIP-TO-SHORE CARGO MOVEMENT			
	RECORD OF EVENTS	WORKSHEET/LOG	
	WEATHER & SEA CONDITIONS	MEASURING DEVICES	
1. DETAILED TIMES BY LINK & NODE FOR EACH TYPE CRAFT IN MOVEMENT FROM SHIPSIDE TO SHORE & RETURN	RECORD OF TIME OF EACH SEGMENT OF CRAFT TRIPS	WORKSHEET/LOG	OPERATIONAL TECHNIQUES PLANNING FACTORS EQUIPMENT REQUIREMENTS
	REASON FOR DELAY, IF ANY.	WORKSHEET/LOG	
2. QUANTITY OF CARGO MOVED FROM SHIP TO SHORE & RETROGRADED BY TRIP (NO. - TYPE - WEIGHT)			DITTO
3. COMPARATIVE MANPOWER REQUIREMENTS FOR EACH TYPE CRAFT	CONTAINER/TONS PER MAN PER DAY MOVED BY EACH TYPE CRAFT	WORKSHEET/LOG/TO & E & TA	FORCE STRUCTURE
	MEASUREMENTS 1, 2 & 3 AT DIFFERENT OFF-SHORE DISTANCES AND IN SEA CONDITIONS NOT ATTAINABLE IN FIELD TEST	PROPOSED LOTS SYSTEM SIMULATION MODEL	PLANNING FACTORS FORCE STRUCTURE
PHASE II C – SHORESIDE DISCHARGE & INITIAL PLACEMENT OF CARGO			
	RECORD OF EVENTS	WORKSHEET/LOG	
	WEATHER & SEA CONDITIONS	MEASURING DEVICES	
1. DETAILED TIME OF EACH CARGO MODULE LIFT FROM ARRIVAL OF CRAFT TO COMPLETION OF LIFT	RECORD OF TIME OF EACH SEGMENT OF SHORESIDE DISCHARGE EVENT.	WORKSHEET/LOG	OPERATIONAL TECHNIQUES PLANNING FACTORS EQUIPMENT REQUIREMENTS
2. QUANTITY OF CARGO EXTRACTED FROM CRAFT & INITIALLY POSITIONED (NO-TYPE-WEIGHT)	REASONS FOR DELAY, IF ANY	WORKSHEET/LOG	DITTO
3. COMPARATIVE MANPOWER REQUIREMENTS FOR EACH SHORE-SIDE SUB-SYSTEM	TONS PER MAN PER DAY EXTRACTED & POSITIONED BY EACH SUB-SYSTEM	WORKSHEET/LOG, TO & E, TA	FORCE STRUCTURE
	MEASUREMENTS 2 & 3 IN DIFFERING SEA CONDITIONS NOT ATTAINED IN FIELD EXERCISE	PROPOSED LOTS SYSTEM SIMULATION MODEL	PLANNING FACTORS FORCE STRUCTURE

DATA COLLECTION OUTLINE (Continued)

MEASUREMENT	DATA REQUIRED	DATA COLLECTION METHOD	TEST OBJECTIVE APPLICATION
PHASE III A – SHORESIDE CARGO HANDLING & MANAGEMENT			
	RECORD OF EVENTS	WORKSHEET/LOG	
	DISCHARGE DELAYS ATTRIBUTABLE TO CARGO CONGESTION	WORKSHEET/LOG	
1. WAITING TIME OF EACH CARGO MODULE AT BEACH DISCHARGE SITE PRIOR TO MOVEMENT TO MARSHALLING AREA	DETAILED TIME RECORD OF CARGO FROM ARRIVAL ON BEACH TO DISPATCH	WORKSHEET/LOG	OPNL TECHNIQUES PLANNING FACTORS EQUIPMENT REQUIREMENTS
2. PERCENTAGE OF CARGO ACCURATELY IDENTIFIED AND INVENTORIED IN MARSHALLING AREA	VERIFICATION OF STAGING AREA ACCOUNTING RECORDS	PHYSICAL INSPECTION/WORKSHEET	OPNL TECHNIQUES
3. TIME REQUIRED FROM RECEIPT OF MOVEMENT ORDERS TO DISPATCH OF CARGO	TIME RECORD OF PERSONNEL ACTIVITIES	WORKSHEET/LOG	OPNL TECHNIQUES EQUIPMENT REQUIREMENTS
4. COMPARATIVE MANPOWER RQMTS. FOR CONTAINER/CONVENTIONAL CARGO HANDLING & MANAGEMENT	PERSONNEL MANNING DATA FOR HANDLING & MGMT. FUNCTIONS FOR CONTAINER/CONVENTIONAL CARGO	WORKSHEET/LOG, TO & E; TA	FORCE STRUCTURE
PHASE III B – INLAND CARGO MOVEMENT, RECEIPT & RETROGRADE 1/			
1. TIME REQUIRED TO RECEIVE & OFFLOAD CARGO	RECORD OF TIME OF CRITICAL EVENTS	WORKSHEET/LOG	OPNL TECHNIQUES PLANNING FACTORS EQUIPMENT REQUIREMENTS
2. PERCENT OF CARGO/CONTAINER RECEIVED THAT IS ACCURATELY IDENTIFIED	VERIFICATION OF LOTS TERMINAL DOCUMENTATION	PHYSICAL INSPECTION/WORKSHEET	OPNL TECHNIQUES
	DATA ASSUMING DIFFERENT INLAND DESTINATION DISTANCES THAN THAT IN FIELD TEST & VARIATION OF SHIPMENT VOLUME BY TYPE DISTRIBUTION (i.e., DIRECT THRU-PUT, WORKING FROM "POOL" ETC.)	PROPOSED LOTS SYSTEM SIMULATION MODEL	PLANNING FACTORS FORCE STRUCTURE

1/– SCOPE OF THIS ASPECT OF LOTS SYSTEM IS PRIMARILY TO ADDRESS INTERFACE OF TRANSPORTATION & SUPPLY FUNCTIONS, NOT AN IN-DEPTH EVALUATION OF SUPPLY DISTRIBUTION SYSTEM

DATA COLLECTION OUTLINE (Continued)

points. Elapsed times for particular activities will be obtained by subtraction. This method of recording the data insures that all delays will be included.

The main measuring instruments in the test will be continuously running watches, capable of being read to the nearest second. Observers will have their watches synchronized. The synchronization will be important for situations where observers are recording intermeshing events, and will insure that changes in wave height etc. can be properly accounted for in the various records of simultaneously occuring events. (Use of quartz-crystal controlled wrist watches would minimize the need to make arithmetical corrections to individual watch times. Consideration should be given to use of digital readout faces on the watches).

Records will be made of wave heights with portable recorders. Wind direction and strength, tide level, distances between the ships and shore, sand conditions, and any other pertinent environmental data will also be measured using appropriate instruments.

For the portion of the test concerned with the inland receipt and storage phase, one of the measurements will be the percent of contair or pallet loads of breakbulk cargo that is misidentified or mis-addressed. These will be determined by careful comparisons of records kept during the ope ti .

APPENDIX E

DURATION OF TESTS

SUMMARY

This appendix outlines the factors affecting the duration of the main test. The preliminary design of the test, described in Section IV, is based on a number of such factors. These include: the desirability of measuring a sustained, representative, throughput of containers under the changing conditions of a ship being unloaded; the need for sufficient repetitions of the container-transfer cycles to provide a sample size having reasonable statistical accuracy for each of the various subsystems tested; and the need to consider the effects of sea-state, which is an uncontrolled variable in the test plan. A final section of the appendix discusses the importance of possible error in measuring ship discharge rates. It concludes that potential errors in current planning factors (which the tests would be expected to reveal) could be expensive in the two areas explored: in establishing lighterage requirements for unloading the ships; and in waiting time for ships.

CONSIDERATIONS CONCERNING DURATION OF TEST

Overall Factors

The test will confirm capabilities to unload containers when normal peacetime port unloading facilities are not available, and will measure the time required. A primary consideration is to make the test representative of future offshore discharge operations. To do so certain conditions are necessary:

- Provide a sustained cargo throughput over a period long enough to go beyond the initial startup problems, and to extend far enough in time to test to some reasonable extent fatigue, stress, wear, and possible buildup of bottlenecks in the overall operation,

- To make the test measurements under the changing conditions that occur as the ship progressively changes from full to empty -- higher freeboard, need for crane repositioning, and the differing

accessability of the cells from which the containers are unloaded -- and as the other components of the LOTS system, such as the lighterage and the shoreside cranes, adapt to such circumstances as changing tides.

- To include a reasonable probability that a variety of sea states and weather will be encountered.

The above led to the recommendation that the two principal crane subsystems for off-loading the containership should each be tested for one full shipload -- 600 containers for the notional containership, 1200 container lifts in all.

Quantitative Aspects of Number of Repetitions of Measurements

The number of repetitive measurements to be planned for subtests is an important design consideration. Clearly too few repetitions could yield inconclusive results. Unnecessarily many would also be inappropriate. In the work leading to the preliminary design, four quantitative aspects of the repetitive measurements were investigated. Of these, the first two of the four listed below provided assistance in quantifying the number of repetitions -- the sample size. The second two are appropriate to consider in the test design but did not in fact have a quantitative impact on the test design and are not discussed further after the brief discussion below. The four aspects investigated quantitatively were:

- From a statistical point of view there is a quantity of trials for each sub-test appropriate to the accuracy needed. Sample size can be worked out from the results of previous tests, combined with estimates of the importance of possible error in the measurements.
- For some portions of the test the sea state can strongly affect the measurements. It is an uncontrolled variable in the tests. The test plan should allow for sufficient tests to accomodate variation in the weather. While data are available on the frequency and severity of heavy weather in the proposed test area, the translation of these data into a recommended numbe. of measurements is not a rigorous procedure.

- In principle there should be some suitable allowance so that the throughput system can arrive at an approximate steady state. That is, the various delays and minor trial-and-error involved in start-up ought to be allowed for in the test design and taken into consideration in the analysis of test results. Preliminary analysis of previous sub-test data, which covered approximately one-hour periods, showed that if the second half of the sub-test timing data is compared to the first half, there is no discernable trend indicating a learning process. This was interpreted as either that (a) start-up effects were small as compared to the considerable variability in the data, or (b) that the test results were not extensive enough for a distinct learning pattern to emerge. Some qualitative weight can be given to (b) by a comment in the test report concerning a crane operator that "within two days he had the feel of the job and . . . lowered his handling times." The conclusion is that there is little basis for taking learning into account in laying out the tests. If the tests extend over several days the data that will be collected presumably can be analyzed to show such trends if they do exist.

- For some new types of equipment the durability under operational stresses has not been proven. The proposed tests, while not a substitute for user tests, do provide an opportunity for use of the equipment in realistic operating environments that might be difficult to provide otherwise. The operating-hour requirement for verifying the predicted mean time between failures for one important kind of newly acquired equipment, the LACV-30, appeared too great to consider. The predicted MTBF is approximately 200 operating hours. Calculations estimate that, for a 90 percent confidence the test would have to continue between 300 and 490 vehicle hours. The proposed test plan, which contemplates using the only two prototype craft that will be available, could provide only about 180 vehicle hours of cargo operations.

ACCURACY OF MEASUREMENT AND THE REQUIRED NUMBERS OF REPETITIONS

Importance of Container Discharge Facility Rates

The crane subsystem used in unloading the ship into lighters is the controlling element in a ship-to-shore operation. This is because it has physical limitations not shared by the operations that follow in sequence -- the transport to shore and unloading the lighters at the shore. Any of the operations following after the crane discharge can in principle be increased in capacity by operating equipment in parallel. The ship-unloading cranes cannot be so increased (two is considered the limit) without interfering with one another. The ship discharge rate is a primary basis for planning factors for ship unloading time, for lighter and ACV unit Tables of Organization and Equipment, and for cargo throughput capabilities of terminal service organizations.

Present planning factors for containers are based on estimates of ship discharge rates extrapolated from performance rates with fixed facilities and on tests that included relatively few measurements. The potential for error in such planning factors is substantial, considering the differences between LOTS operations and port operations from the extrapolated-experience point of view, and considering not only the paucity of the measured data, but also the hour-to-hour and day-to-day variability in the discharge capability being measured. Further, analyses of previous tests did not address how "typical" the sea-states and other operational factors were.

Division of Crane Time into Categories

The working time of the crane subsystem -- that is, the time excluding avoidable delays, breakdowns, maintenance time, and stoppages necessary because of bad weather (but not slowing down of rate because of the weather) -- can be discussed in three categories:

- Initial set-up time, consisting of moving the crane to a position where it can begin work, making necessary adjustments to boom length or to number of parts in the line, etc.
- The repetitive, productive lifts of cargo, and
- Necessary periodic repositioning of crane subsystem to permit reaching into different sections of the ship, removal and replacement of hatch covers, and similar operations that take place between the repetitive lifts.

Note that planning factors for ship turnaround time would be based on time that includes all three time categories. Planning factors for quantities of lighters needed must be based on the (b) category only, because it establishes the maximum rate at which lighters will be needed. Quick turnaround of the ship can be accomplished only if lighters are always available to accept cargo available from the ship.

In the proposed test, the set-up part will necessarily be on a one-time only basis for each of the two crane subsystems that are to be tested (i.e., crane-on-deck and crane-on-barge). While of direct interest in itself, the elapsed time for setup does not affect the repetitive parts of the test design. Portions (b) and (c) do.

As a matter of perspective, a rough estimate is that on the order of 4/5 of the unloading time will be spent on the repetitive lifts of the (b) category and the other 1/5 on the (c) category. The setup time of category (a) is a quite small fraction of the total.

Repetitive Cycles

Aside from interruptions, the crane moving containers from ship to lighter repeats its actions about ten times each hour. But it must reach different distances each time, lift different weights, swing through different angles, place the container in different spots aboard the lighter, and must deal with somewhat different connecting and disconnecting problems for each container. Thus, there is substantial variability in the times measured per cycle. They can be treated statistically as random variables.

Data from the OSDOC II exercise yield an estimate of cycle-to-cycle variance for the ship-to-lighter cranes. A statistical analysis in the report on the test shows that the measurements for the four shipside cranes tested had an average coefficient of variation equal to ± 20 percent. The report makes the comment: "Because of small sample size, a difference of roughly 40 percent [among four different ship off-load systems tested] would have had to exist in order to be detected." The associated confidence level is 95 percent. The quotation means that from a statistical point of view, differences observed in the separate averages measured for each of the four off-load systems could have occurred by chance, given (a) the small number of trials (i.e., 11 lifts, on the average, per off-load system) and (b) the relatively large variability from one cycle to the next.

Replications to Reduce Within-Cycle Uncertainty

Figure E.1 shows the average number of container lifts made per subtest of the four off-load systems in the OSDOC II exericse, and further shows how the uncertainty in the measured mean values would decrease with larger quantities of lifts measured. No between-cycle delays are considered in this section. Furthermore no allowance is made for any change in variance caused by sea-state. While it is clear that increased sea-states would increase the mean time per cycle, there is no data to indicate whether or not there would also be a more-than-proportional increase in the variance of the cycle times.

The projection of the uncertainty figures in Figure E.1 assumes that the percentage figure -- the potential variation in the mean values -- decreases in inverse proportion to the square root of the number of lifts. This is in accordance with a standard rule in statistics concerning the variances of sample means.

FIGURE E.1

NUMBER OF CONTAINER LIFTS AND MEASUREMENT UNCERTAINTY

	Average Number of Crane Cycles per subtest	Potential Variation of of Mean Values, 95 percent confidence level
OSDOC II Tests	11	± 20%
Projections for future tests	44 176 704	± 10% ± 5% ± 2½%

Effects On Ship Unload Cycle of Lighter Type, Ship Configuration, and Container Weight

For containership discharge, the cycle time for the ship unloading subsystem depends to some extent on differences in lighters, ship size and hatch location, and on container weight.

Differences in ship unloading rate attributable to different lighter designs are to be expected. Such differences tend to be submerged in the total cycle time, since, according to a detailed breakdown of cycle times in the OSDOC II report, less than one-third of the total crane cycle occurs with the container at or near the lighter.

Ship configuration presumably will change cycle times, as for example, simply from differences in ship freeboard and beam. (Some other differences, associated with ship configurations that change the between-cycle delays, are discussed in a later paragraph.)

According to analyses of the OSDOC II statistics, differences in container weight appear to have had almost no effect. The current plan for the future tests is to load the containers with dummy cargo in such a way that there will be several groups. In each group, the containers will weigh the same. Taken together, the mix will be generally representative of the weights of resupply cargo. During the tests, the containers will be put into random order with respect to weight. By retaining identification of containers during the tests, correlations of cycle times with weight will be feasible during analysis.

Effects of Sea-States on Test Data Requirements

The weather introduces an uncontrolled variable into data collection. The advent and intensity of heavy weather is unpredictable during the test planning. As wave heights increase, cargo throughput rate diminishes. As relative motion between the cargo and the lighter increases, pendulum effects become more difficult to control, danger to personnel worsens, and the probabilities increase of hard impact between cargo and lighter and between lighter and ship. These effects have not been quantified; what size waves cause how much slowdown is not known even to a rough approximation.

As an example, waves over five feet high are known to have had a substantial slowing-down effect in past breakbulk operations. How much such waves affect container operations, and to what degree operations with some lighter types are likely to result in slower throughput rates than with other lighters, is not known.

If the wave height increases still further, a decision may be made to cease operations. It must be made on the spot, and on an ad hoc judgmental basis. With the current state of knowledge there is no doctrine or instrumentation available that can provide guidance for making the decision.

During the proposed test, the only way open to deal with the possibility of substantial changes in the weather is to plan to collect enough data for adequate samples of periods with different weather. How much allowance is appropriate? In order to try to answer this, preliminary analyses were made of records for a point on the ocean shore near the proposed test site at Ft. Story. Records available for 1966-1968 indicate that in September (the worst month) waves less than five feet high occurred 92 percent of the time.1/

1/ Data obtained from Coastal Engineering Research Center, Ft. Belvoir, Virginia.

Preliminary analyses of these records also yield some feel for the persistence of waves over and under five feet in height. Readings record the average height during successive four-hour periods. The longest time waves over five feet high persisted was three days. This occurred only once in the three years of September records available. Including these three days, there were eight periods with waves over five feet high, and these periods averaged 21 hours in duration. The rest of the time waves were under five feet high. The duration of these under five-feet periods average five and one-half days. (In compiling these figures, any reading for only one four-hour period was counted as a temporary deviation that could properly be included as part of the longer period.)

The conclusions to be drawn with respect to the proposed test are: (a) that during a test that lasts 10 to 12 days, there is a strong likelihood of waves over five feet high occurring; but that (b) the persistence of these waves is likely to be less than a full day. The design of the proposed test makes provision for such weather in two ways. First, the possibility of a shut-down of the test because of weather is allowed for by including "weather days" in the schedule. Second, a large enough quantity of lifts in each subtest is planned so that slowdown in throughput would still allow for acceptable accuracy in the test results. A later section discusses the effect on accuracy of a worst-case reduction in the number of lifts -- 25 percent. The resultant increase in the uncertainty of the averages of the subtests is shown.

Between-Cycle Interruptions

Compared to the productive cycles discussed above, the between-cycle interruptions take a considerably smaller fraction of the total ship discharge time. Data from previous tests on these neccesary interruptions is even more limited than for the cycle times. Questions need to be answered on how frequently they will occur (on the ship being tested and on other ships),as well as how long they will take.

Two main parts take up most of this time category: moving hatch covers and repositioning the crane. To estimate the number of measurements involved with hatch covers, assume that the containership available for the test turns out to have a 600-container capacity. Such a ship will have on the order of 15 hatch covers. Each will have to be removed once and replaced once, or about two hatch-cover movements measured per each 40 containers. The OSDOC II exercise report indicates that the shipboard crane required 10 minutes for each hatch cover movement on the average. It does not report on the variability of the 14 time measurements made. As an estimate, it is assumed that the standard deviation of the times is in the same ratio to the

mean value as it is for the container lifts shown in the report. This ratio is 0.4. The estimated value of the standard deviation, then, is 4 minutes. Since 14 lifts were made, the standard error of the mean would be $4 \div \sqrt{14}$ or 1.07 minutes. Ninety percent confidence limits on this basis, then, would be 10 minutes $\pm$ 2 times 1.07 minutes. The possible error of the average of OSDOC measurements of hatch cover time would be from about 8 minutes to 12 minutes.

For the proposed new tests the increased number of measurements -- 30 hatch cover movements for each of the two crane systems instead of 14 -- yields an estimated increased accuracy for each system. Assuming the same conditions as the OSDOC, the standard error would become $4 \div \sqrt{30}$, or 0.73 minutes. The 90 percent confidence interval would be 10 minutes $\pm$ 2 X 0.7 or 8.6 to 11.4 minutes. It may prove appropriate to combine the readings for the two systems, in which case the standard error would be reduced to $4 \div \sqrt{60}$, or 0.52, and the error of the overall average plus or minus one minute.

The second main part of the between-cycle delay is repositioning the crane. For a 600-container ship, this would probably be required something like eight times. For the crane-on-deck configuration the OSDOC II report shows that repositioning the 70-ton capacity mobile crane from one hatch to another was accomplished in 11 to 15 minutes. Thus, the eight repositionings per crane system in the proposed test could well be accomplished at an average of about twelve minutes each. Statistically, this number of measurements is small, and the potential error of the mean may be high. But by the same token, the small quantity indicates that the overall impact of the measurement on the throughput of containers is not as great as, for example, the hatch-cover time measurements.

Note that still other interruptive between-cycle times can be anticipated. Re-rigging or adjustments of crane rigging, possible refueling of the crane, and similar short delays are all part of this time category. In the evaluation of the test results, study will be required to determine which of these delays should be regarded as typical and appropriate to include in establishing planning factors.

Replications in Proposed Tests

Figure E.2 shows a proposed schedule and breakdown of container lifts for different subtests. The relative shares of the total lifts allocated to the different lighters is based on forecasts of their capabilities. The LACV-30s are given as large a share of the load as the limited number of prototypes will permit, in order to test their capability. Only two prototype LACV-30s

FIGURE E.2

TENTATIVE SCHEDULE OF LIFTS OF 20' CONTAINERS FROM NSS CONTAINERSHIP

	Crane-on-deck				Crane-on-barge			
Lighter / Test Day	6th	7th	8th	Totals	10th	11th	12th	Totals
LACV-30	70	135	75	280	75	135	70	280
LCU & LCM-8	80	135	75	290			80	80
Helicopter	--	30	--	30	--	---	--	---
Causeway Ferry	--	---	--	---	75	165	--	240
	150	300	150	600	150	300	150	600

FIGURE E.3

STATISTICAL UNCERTAINTY OF SUBTESTS (DELAYS NOT INCLUDED)
Showing Potential Variation of Mean Values at 95% confidence level, for indicated quantities of lifts, and for 75% of indicated quantities, to allow for a worst-case reduction for weather slowdown.

	LACV-30s			LCUs and LCM8s			Causeway Ferry			Helicopter	
	Lifts	% Uncer. good weather	% Uncer. with weather slowdown	Lifts	% Uncer. good weather	% Uncer. with weather slowdown	Lifts	% Uncer. good weather	% Uncer. with weather slowdown	Lifts	Total Lifts
Crane on Deck (Initial three days of unloading)	280	± 4	$\pm 4\frac{1}{2}$	290	± 4	$\pm 4\frac{1}{2}$	---	--	--	30	600
Crane on Barge (Final three days of unloading)	280	± 4	$\pm 4\frac{1}{2}$	80	± 7	$\pm 8\frac{1}{2}$	240	4	$4\frac{1}{2}$	--	600
Totals	560			370			240			30	1200

will be available at the scheduled time of the proposed test. The capabilities of the LCUs and LCM-8s are better known, so they are allocated a fill-in role. The number of helicopter lifts is low because the helicopter is included in the test primarily to evaluate the effects of down-wash on other unloading that is proceeding simultaneously, not for its evaluation as a major cargo discharge subsystem.

Figure E.3 shows that same breakdown of subtests, but in a different format. The purpose of this table is to show the best available forecasted statistical uncertainty of the subtests. Two figures are given, one for the indicated quantities of lifts, and one for a quantity reduced by heavy weather to 75 percent of the indicated values. This is intended as a worst-case demonstration. The table indicates that a degradation because the weather cuts down the quantity of lifts would not be serious in terms of accuracy.

IMPORTANCE OF POSSIBLE ERROR IN SHIP DISCHARGE RATE MEASUREMENTS

The effects of an error in the ship discharge subsystem rate is investigated next, using first a rough model of ship to shore lighterage requirements and later using a ship queueing approach. The lighterage requirements are based on the maximum throughput with no delays; the queueing approach includes the effects of delays. The approaches are intended to show that proper establishment of the discharge rates is important to the proper balancing of the LOTS system.

Results of past exercises, as discussed in a previous section, may have been in error because the data had so few measurements, and the measurement results were so widely scattered, that there was a possibility of substantial errors.

Rough Model For Establishing Lighter Requirements from Ship Discharge Rate

The rough model assumes that: the ships are discharged using one container discharge facility and a group of a single type of lighter -- either ACVs, LARC-60s, LCM-8s, or LCUs; the ships average one mile from the shore; effects of heavy weather are not considered; and queues of lighters at the ship are necessary in order to compensate for the variations in ship discharge rates and lighter arrival rate. Further detailed assumptions are shown in Figures E.4 and E.5.

FIGURE E.4

ASSUMPTIONS AND CALCULATIONS USED IN ROUGH MODEL FOR EVALUATING IMPORTANCE OF AN ERROR IN SHIP DISCHARGE RATE MEASUREMENT

ASSUMPTIONS

1. Delays caused by moving hatch covers, relocating cranes, etc. not considered in calculation (to do so would reduce maximum requirement for lighters).

2. ACVs, LARC-60s, and LCM-8s carry 2 twenty-foot containers each. LCUs carry 6.

3. ACVs move at 40 kts; LCU, LARC-60, and LCM-8 at 8kts.

4. Time required to moor to ship, cast off, beach, and retract:

   Landing Craft and LARC-60 — 15 minutes; LACV-30— 5 minutes

5. Tie-up times at ship assumed to lose no time for crane.

6. Note: Beach crane assumed to take 80% of the time of ship crane, per container (i.e., .80 x 5.92 min) = 4.74

CALCULATIONS, ASSUMING NO ERRORS

Lighter Cycle Times	LCU	LARC-60s or LCM-8s	LACV-30s
Load from ship	6x5.92=35.52	2x5.92=11.84	2x5.92=11.84
At beach crane	6x4.74=28.42	2x4.74=9.47	2x4.74=9.47
Mooring and beaching	15.	15.	5.
Underway time (2 miles round trip)	15.	15.	3.
	93.94 min	51.31 min	29.31 min
Lighter "Working Rate" = Containers ÷ Cycle time	.0639	.0390	.0682
Crane Working Rate Containers/Minute	.1688	.1688	.1688
Number of Lighters needed, no queuing (= crane w.r. ÷ lighter w.r.)	2.64 lighters	4.33 lighters	2.47 lighters
For queuing, add 15%.*	3.04 lighters	4.98 lighters	2.84 lighters

*Rule of thumb from Johns Hopkins, ORO-T-361: to assure lighter ready 98% of the time, add 15% to number calculated without queue.

The calculations in Figure E.5 below show how the quantities of lighters needed would change if it were to be discovered, as a result of future tests, that an adjustment is necessary in the ship discharge rates. In general, the postulated 10 percent change up or down in the ship discharge rate yields a lesser change - - 2 to 7 percent - - in the lighter requirements.

As an example of the effect, the forecast 10-year cost for enough LACV-30s and LARC-60s to provide the capability to meet the ME-1 scenario[2/] requirements is just over 50 million dollars; the calculated effect of a 10 percent error in the discharge rate would be to increase or decrease the figure by approximately $2.5 million. Note that this includes maintenance costs but does not include personnel for operating. The costs for terminal service units is also influenced by any error in the ship discharge rate, and could also be considered in an assessment of the fiscal impact of potential error.

FIGURE E.5

CALCULATIONS, ASSUMING PLUS AND MINUS 10% ERRORS IN SHIP UNLOADING RATE

	LCU		LARC-60 or LCM 8		LACV-30	
Lighter Cycle Times	+10%	-10%	+10%	-10%	+10%	-10%
Unload	39.07	31.97	13.01	10.68	13.01	10.68
Beach Crane	31.26	25.58	10.42	8.52	10.42	8.52
Mooring, etc. + Underway	30	30	30	30	8	8
Total Cycle Time	100.33	87.55	53.43	49.20	31.43	27.20
Lighter Working Rate	0.0598	0.0685	.0374	.0407	.0636	.0735
Crane Working Rate	.154	.188	.154	.188	.154	.188
Lighters needed, no queue	2.58	2.74	4.11	4.62	2.42	2.56
Lighters needed, with queue	2.96	3.16	4.73	5.32	2.78	2.94
% Change from No Error	-3%	+4%	-5%	+7%	-2%	+4%

Queuing of Ships

One potential consequence of an error in planning factors is the possibility of a waiting line of ships forming. In past wartime situations, there have been occasions when substantial and wasteful queues of ships have formed, waiting to be unloaded. The waiting lines occur when the unloading capability at a harbor or far shore does not suitably match the arrival rate of the ships.

2/ U. S. Army Transportation School, U. S. Army Trans-Hydro Craft Study Scenario Excursion, Ft. Eustis, Virginia, August 1974.

The potential for mismatch can be discussed at two levels. One is what might be termed gross mismatch, where the available facilities are clearly only a fraction of what is needed. The results of such a mismatch can be calculated in a simple manner. The second is a more subtle mismatch, where the arrivals and the capabilities on the average are in fact rather closely matched, yet where according to queueing theory, a waiting line of serious magnitude can build up, (and has been shown to do so in at least one paper that compares the theory and actual waiting lines of ships). The theory takes into account a representation of the variability in ship arrival times and in ship unloading rates that actually occurs. That is, ships arrive earlier or later than scheduled, although the average schedule is adhered to, and the unloading operation is completed earlier or later than planned. Both the variability of the ship arrivals and the variability of the unloading rates can be represented as frequency distributions.

The left hand part of Figure E.6 shows the result of calculations intended to illustrate the gross mismatch. The diagonal line at the left of the figure shows the number of ships that would be waiting for service at the end of 30 days with the assumed arrival rate of exactly one per day. Following the 30 day line diagonally down toward the right, if 100 percent of the needed service facilities were available, no ships would be waiting at the end of 30 days. Similar straight lines show the consequences at the ends of longer periods.

The right hand side shows curves that take into account variability in the arrival rates and in the servicing rates. These represent the steady-state queue length that would occur after an indefinitely long period of operation. Presumably in actual operations no such indefinitely long period would occur. Nonetheless, the curves give a general appreciation of the potential problem that can arise even when service facilities that seemingly are enough are available.

If actual rates were 10 percent lower than the planning factor, this would result in about a 6-ship waiting line at the end of 60 days, even with variability not considered. For the 60 days an average of 3 ships would be waiting and this would be 180 idle ship days. At $30,000 per ship-day this would cost $5,400,000.

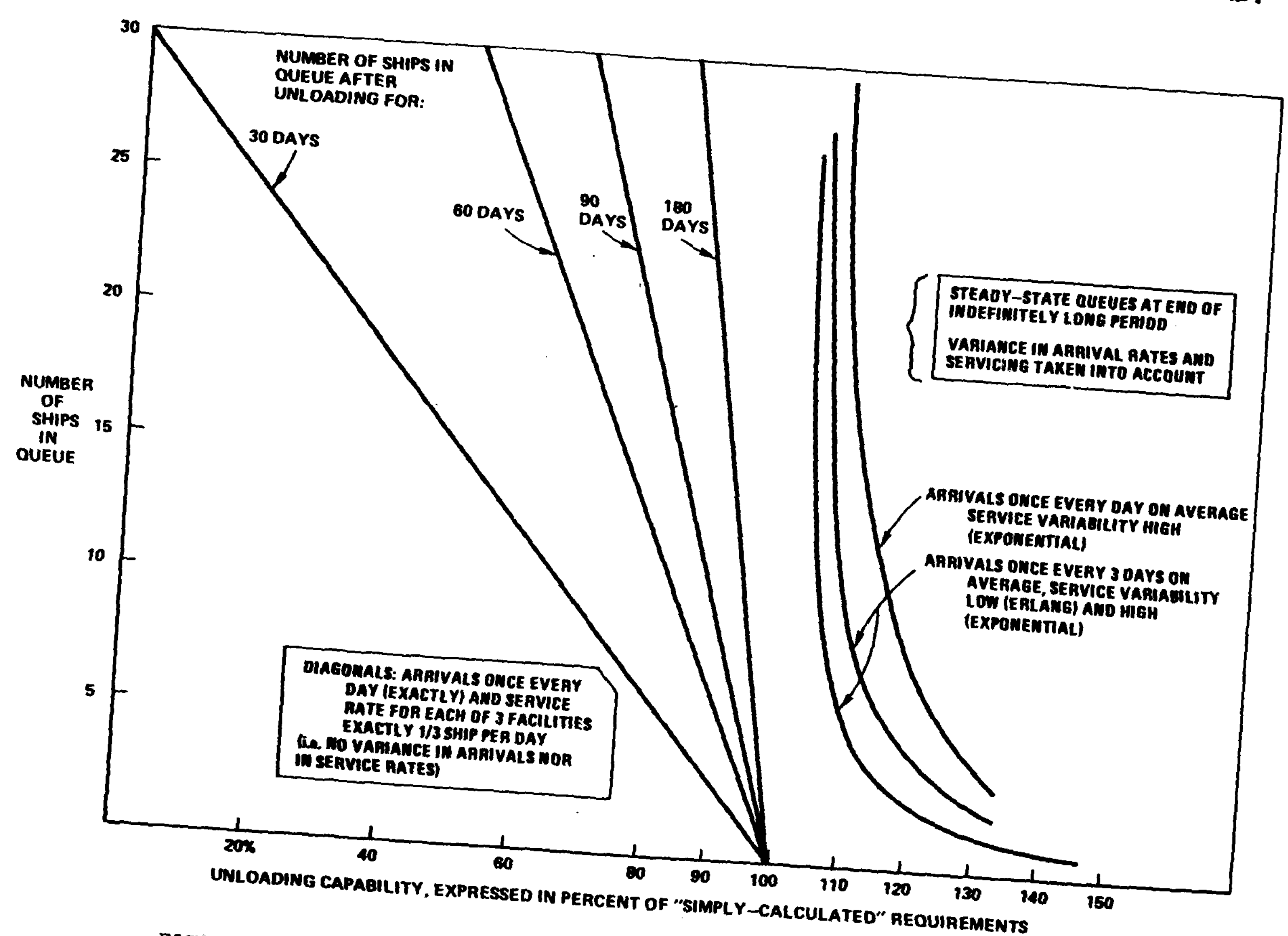


FIGURE E.6 NUMBER OF SHIPS IN QUEUES, CALCULATED FOR VARIOUS TIMES (a) WITHOUT AND (b) WITH VARIANCES IN ARRIVAL AND SERVICING RATES TAKEN INTO ACCOUNT

APPENDIX F

CONTAINER SIZES AND WEIGHTS

SUMMARY

This appendix discusses the choice of container size and weight for the proposed test, and the effects of the choices. It is proposed that the bulk of the containers to be used be 20-footers, with special tests of 40-footers. Two opposing viewpoints on weight of containers are presented. The first is that for future LOTS operations, special light loading of containers will be necessary, and thus the containers in the test should be correspondingly light. The opposing viewpoint is that the services must be able to make use of available commercial assets and facilities in the future, and the weights for the test should be representative of peacetime operational practices (that is, not using special light loading).

For the test it is proposed that a mix of representative container weights be used. An example is shown in Figure F.1 of an actual frequency distribution of container weights. It is recommended that the choice of distribution for the test should be made with care, as capabilities can be affected. This is demonstrated by a brief analysis that uses the LACV-30 as an example.

SIZES

The choice of container sizes for the tests involves considering (a) the policy of using commercially available assets, and (b) studies of container use by the military. Commercial container sizes are standardized reasonably well as to width (8 ft.). They are also standardized quite well as to height (8 ft.) although generally speaking, differences in height would not usually make so much difference operationally as differences in width or length. Lengths most used are 20 feet, 35 feet, and 40 feet. Army cargo currently being shipped in commercial containers is divided into roughly 1/3 for each of these lengths.

Army and Marine Corps studies of future uses of container systems in a LOTS environment (these studies are discussed in Appendix B) have recommended use of 20-foot containers, based on both size and weight considerations. Development programs are underway for restraint systems that would permit using 20-foot commercial containers for ammunition [1/], which has greater density than most other cargo. Studies and tests using military-owned special containers have indicated that attractive savings in time, cost and manpower are possible if such a commercial container system can bc made workable for ammunition. The inherent hardware design problems, however, are substantial. (No similar problem in using the specially designed 20-foot MILVAN containers for ammunition has been noted).

1/ Initial plans for the LOTS test do not include any special tests for ammunition. Its handling is basically no different from other container cargo, although for safety, separate LOTS sites are customarily established.

The preliminary design of the proposed LOTS tests concentrates on 20-foot containers. Addition of a limited number of 40-footers is planned for, subject to pre-testing. This approach conforms to current service thinking, while recognizing the potential requirement to cope with exceptions in the form of larger containers.

CONTAINER WEIGHTS

Limits on Weights

The weights of cargo to be used in the containers during the test are important in making the test realistic. A mix of container weights that approximates the mix that can be expected in future LOTS operations is a goal for the design of the test.

There remains the question of whether it is realistic to expect that special light loading of containers, specifically for LOTS operations, would be used in a future conflict. A previous paragraph noted that limiting the length to 20 feet appears appropriate to some military authorities; whether the weight should also have a specific limit for LOTS tests, and what it would be if imposed, are questions at issue. (The physical limit imposed by the strength of standard rated 20-foot containers, a gross weight of 22.4 short tons, is accepted and is not considered further here).

Two opposing points of view need to be considered. The first is that a LOTS operation and the subsequent inland movements of containers will strain available equipment capacity. Even with a load limit of 13 short tons (20 ft. commercial containers used for military cargo currently average just under 13 tons gross)[2/], much of current material handling equipment and vehicles are working at or near maximum capacity. They will have the additional stresses of working under beach conditions.

The other point of view holds that commercial containers on the average are increasing in size and weight, and the Armed Forces dependence on commercial support is increasing. The services must be able to make use of whatever commercial system is in being at the time of a future conflict, because that will be the major part of the available transport. Thus, to make the proposed LOTS test realistic in the sense of representing likely future operations, weights should not be unrealistically reduced.

2/ Data obtained informally from Military Traffic Management Command, for July 1974.

Distribution of Mix of Weights

For the test, regardless of upper limits, a mix of container weights is planned. There would be groups of containers in weight classes. These might be patterned, for example, on the data in Figure F.1. which shows the percentages of containers in five cargo weight classes for DOD cargo that was shipped during July of 1974. It applies only to 20-foot containers. Note that the basic data classes do not include the weights of the containers themselves. In the test a mix similar in principle to the one illustrated by the figure is proposed.

To show the possible variability of the mix, Figure F.2. has been prepared. It was compiled from Appendix J of the USATRADOC Trans-Hydro Study, which describes in detail a scenario developed to provide "a realistic portrait of the nature of the cargo and equipment to be transferred from ships anchored offshore to theater-based locations". The appendix shows detailed analyses, by classes of supply, of the containerized cargo for a substantial theater force. As will be seen by the figure, the distribution is concentrated in two groups of container weights. Most of the distribution is in Classes I, II, VI, VIII, and IX. The gross container weights for these classes are in the narrow band of 11.1 to 12.4 short tons. The remainder is Class III, Class IV, and Class V, all at 22 short tons.

For ease in analyzing the test results, it is planned to arrange that the test cargo be so distributed that the weights will be centered close to the mid-points of the weight classes. (For example, to represent the 25.8 percent of containers in the 5- to 10- ton class of the first figure, the same percentage of the total tested would be used, but all the container contents would be within say plus or minus 100 pounds of the 7.5 tons midpoint). In the test it is planned to distribute the various weights of containers in random order with respect to removal from the ship. For analysis, the weight of each container will be available from its number designation recorded on the data sheets, or the weight may be shown directly on the container itself.

Importance of Weight. The weights of the containers are important in some aspects of the test and less important in others. Overall, it seems clear that having weights that approximate the loads to be carried in actual operations will stress equipment appropriately. Handling the substantial weights involved demands care and respect on the part of personnel, while unrepresentatively light weights would permit shortcuts. On a ship or lighter that has a rolling motion the difference between a loaded and an empty container can be substantial, especially to a man handling tag lines. On the other hand, limited tests made in OSDOC II unloading containers from a ship into an LCU, showed no measurable differences in time between light containers and heavy ones.

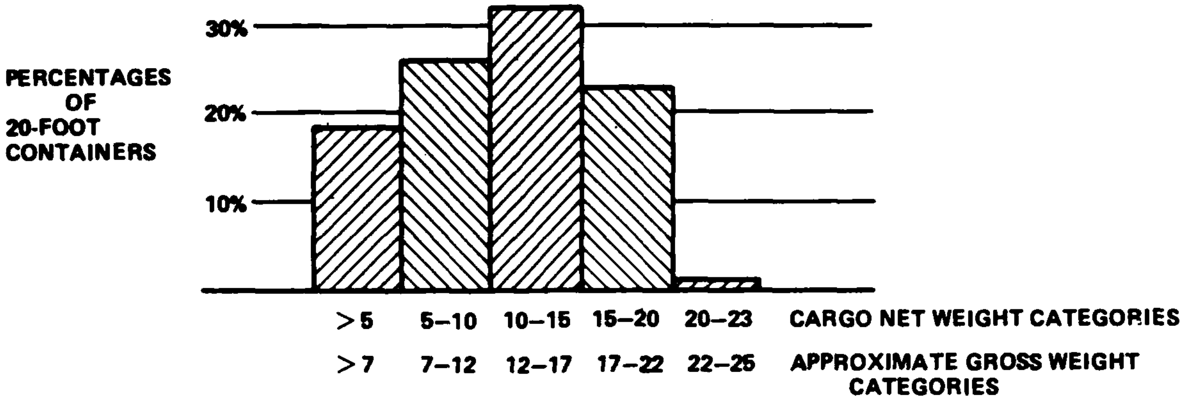


FIGURE F.1 PERCENTAGES OF 2973 TWENTY-FOOT CONTAINER LOADS OF DEFENSE CARGO SHIPPED DURING JUNE 1974 THAT WERE IN FIVE DIFFERENT CARGO-WEIGHT CATEGORIES (SHORT TONS)

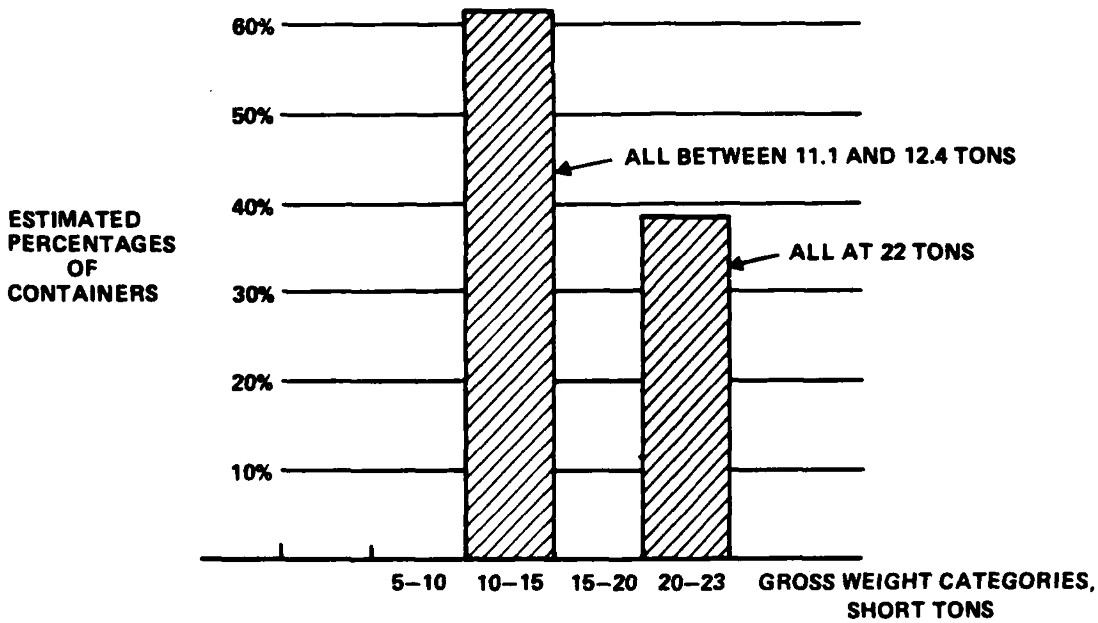


FIGURE F.2 PERCENTAGES OF CONTAINER LIFTS IN WEIGHT CLASSES, AS ESTIMATED FROM CLASS OF SUPPLY REQUIREMENTS FROM A TRANS-HYDRO SCENARIO OF THEATER REQUIREMENTS

Weight Distribution and the LACV-30. The design capacity of the LACV-30 is 30 tons. The average loaded containers of the first figure above weighs 13 tons. Two would weigh 26 tons. The LACV would easily be able to carry two average containers. However, if the containers are stowed randomly with respect to weight, sometimes the containers selected will happen to sum to a total weight over 30 tons. Then the LACV-30 presumably would take only the first container, leaving the second for the next LACV.

A calculation was made of the probability that the sum of the gross weights of any two containers selected at random (from a distribution of weights like that shown in the first figure) would be more than 30 tons. The calculation shows that 20 percent of the time the total loaded weight of the two containers would be over 30 tons. But note that this result is highly sensitive to the lift capability of the LACV-30 and the distribution selected. For example, if the lift capability is only 29 tons, the calculated probability that the two selected containers would be over 29 tons is 42 percent. It is concluded that for the proposed test the weight distribution and the lift capability of the lighters should both be determined with particular care.

APPENDIX G

SITE SELECTION

SUMMARY

This appendix shows the criteria that were used in selecting the proposed site for the main test. It emphasizes particularly the topography of Ft. Story and beach sites in representative strategic areas.

GENERAL REQUIREMENTS

The table below outlines the criteria that were used in test site selection:

- PROXIMITY TO MAJORITY OF PARTICIPATING UNITS. (PREFERABLY ARMY-NAVY-MARINE COMPLEX).
- PROXIMITY TO MAJOR COMMERCIAL OCEAN TERMINAL (TO FACILITATE AVAILABILITY/ACCESS TO COMMERCIAL SHIPS).
- CONTIGUOUS TO OR IMMEDIATE VICINITY OF MILITARY POST/ BASE FOR ADMINISTRATIVE/LOGISTICS SUPPORT AND ANY REQUIRED TRAINING OR MAINTENANCE FACILITIES.
- OCEAN BEACH AT LEAST .5 MILES IN LENGTH, 300 FT. DEPTH, WITH 2 ACCESS ROADS.
- OFFSHORE ANCHORAGES OF 50' DEPTH AND VARIED, REPRESENTATIVE, MODERATE SEA CONDITIONS. PROXIMITY TO SHELTERED ANCHORAGES FOR ADVERSE WEATHER HAVEN.
- 25-30 ACRES OF RELATIVE OPEN, FLAT AREA FOR CARGO MARSHALLING AND EQUIPMENT OPERATION AND COMMAND AND CONTROL FACILITIES.
- BEACH GRADIENT SUITABLE FOR BOTH LANDING CRAFT AND AMPHIBIANS.
- PROXIMITY TO AVIATION SUPPORT FACILITIES.

TOPOGRAPHY

Beaches vs Other Sites

A LOTS operation could be conducted in a wide spectrum of sites from a topographic point of view. The range includes beaches with their implication of open-sea anchorage for a ship being unloaded, and their problems of vehicle traction. The range also includes estuaries, with possible welcome shelter for the anchored ship or the lighterage, but with the possibilities of soft soil or mud at the landing places. Beaches are customarily chosen. A study of certain areas of the world considered strategically important indicates that usable beaches -- defined as having at least a 200 yard length, 100 foot width, clear sea approaches and exits, and terrain that permits movement -- are available in the parts of the world studied[1]. They represent from 0.2 to 40 percent of the coast lines examined, and averaged 10 percent. It is appropriate, then, to select a beach as a test site.

Flat Beach Slopes

In the referenced document the slopes of beaches immediately offshore are shown for selected strategic areas. Eighty-one percent of all usable beaches have a near-shore gradient flatter than 1:61. Measurements scaled from a 1:20,000 chart of the landing area at the proposed test site at Ft. Story, Virginia show gradients averaging approximately 1:120. The Ft. Story site, then, can be considered to be typical of landing sites in strategic areas with respect to offshore gradient.

The reason for concern with gradient is presented in Figure L-16 in the referenced document entitled "Ranges in beach gradients and lighterage types able to negotiate them." Although this Figure indicates that the LCM-8 and the LCU landing craft are not able to negotiate beaches flatter than 1:61, both these craft have shown repeatedly the capability to land and discharge cargo at Ft. Story.

Beach Trafficability

Beach sand typically is difficult for vehicles that do not have all-wheel drive or tracks. Ft. Story provides a suitably difficult mobility problem for vehicles. During the course of the proposed test it is planned to stabilize the soil or lay matting to improve trafficability in heavily worked areas.

SHIP TO SHORE DISTANCES

In a real LOTS operation the distance from ship to shore will be as short as permitted by the ship draft and available water depth. While appropriate

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1/ Trans-Hydro Final Draft (U) Appendix L: Environmental Data.SECRET Dept. of Army Report USATRADOC Transportation School, Dec. 1973.

attention must be given to problems of defense for the ships and for the operation, the LOTS operation itself is assumed to take place without direct opposition. In the proposed test there is no need to make lighter travel distances "typical"; if a shorter or longer distance is envisioned the change in time required is readily calculated from the known speed of each lighter. Thus, the only requirement for the site from the point of view of ship-to-shore distance is that the distance is not so large as to make the test impractical.

APPENDIX H

ESTIMATE OF SERVICE SUPPORT REQUIREMENTS JOINT LOTS TEST 1/

SUMMARY

Service	Pre-Test (FY 76-76T)	Main Test (FY 77)
Army	- System equipment and crews - Load teams - Lashing material and labor - RO/RO ramp assy. - Tech support (TOMMS) - Training, travel and TDY (Total - 175K)	- System deployment elements - Composite terminal Bn - Engr port constr Det. - DSU/GSU Det. - Site administration and log support - Training, travel and TDY (Total - 260K)
Navy	- Causeway sec. and crew - Load teams - Lashing materiel and labor - Lift beam checkout - Training, travel and TAD (Total - 75K)	- System deployment elements - Amphibious constr. Bn Det. - NAVCHAPGRU Det. - Firefighting, crash and rescue teams - Training, travel and TAD (Total - 160K)
USMC	- Travel and TAD (Total - 10K)	- Shore party Det. - CH-53E and crew - Training, travel and TAD (Total - 35K)
Totals	260K	455K

1/ Based on illustrative test schedules discussed in Sections IV and V. Estimates are for O&M cost. Does not consider unit training activity which might be used to reduce cost if integrated with test program support.

SERVICES
PRE-TEST SUPPORT REQUIREMENTS
EQUIPMENT & PERSONNEL
(Based on illustrative test schedules)

I - CONTAINER SHIP DEPLOYMENT EVALUATION:

ITEM	TIME	SVC	ESTIMATED COST
EQUIPMENT			
1 - Mobile Crane (150 Ton)	6 Days	Army	None-SVC Owned
1 - LACV 30	6 Days	Army	None-SVC Owned
2 - LCM8	6 Days	Army	None-SVC Owned
AM/2 Matting		N/MC	None-SVC Owned
Loading & Lashing Equipment & Labor		Army	15K
PERSONNEL			
25 - Loading Team (Terminal Service Company)	6 Days	Army	None-Unit Training
12 - Equipment Crews (LACV 30 & Boat Company)	6 Days	Army	None-Unit Training
		(Sub-Total: A-15K)	

II - BREAKBULK SHIP DEPLOYMENT EVALUATION:

ITEM	TIME	SVC	ESTIMATED COST
EQUIPMENT			
1 - Mobile Crane (250-Ton Capacity)	4 Days	Army	None-SVC Owned
2 - LCU/LCM	4 Days	Army	None-SVC Owned
1 - LARC LX	4 Days	Army	None-SVC Owned
1 - 20T R/T Crane	4 Days	Army	None-SVC Owned
1 - D7 Dozer	4 Days	Army	None-SVC Owned
Loading & Lashing Equipment & Labor		Army	20K
PERSONNEL			
35 - Loading Team (Terminal Service Company)	4 Days	Army	None-Unit Training
25 - Equipment Crews (Boat Unit)	4 Days	Army	None-Unit Training
		(Sub-Total: A - 20K)	

III - BARGE SHIP DEPLOYMENT EVALUATION:

ITEM	TIME	SVC	ESTIMATED COST
EQUIPMENT			
1 - Lift Beam Device	6 Days	Navy	20K (Service Owned - cost for transportation, installation & checkout)
1 - Set, Elevated Causeway	6 Days	Navy	None-SVC Owned
1 - Mobile Crane (Heavy)	6 Days	Army	None-SVC Owned
1 - Barge, Heavy (Type "B" Delong2/)	6 Days	Army	None-SVC Owned
Loading & Lashing Equipment & Labor		Army Navy	10K 10K
NON-SELF-DEPLOYABLE AIRCRAFT (SIDE TEST)			
2 - UH-1	3 Days	Army	None-SVC Owned
1 - CH-47	3 Days	Army	None-SVC Owned
2 - Ship Barges	3 Days	Army	19K
Loading & Lashing Equipment & Labor		Army	15K

2/ Only if SEABEE Ship Available.

ITEM	TIME	SVC	ESTIMATED COST
PERSONNEL			
15 - Loading Team	6 Days	Navy	5K (TDY)
15 - Loading Team	6 Days	Army	None-Unit Training
10 - Equipment Crews	6 Days	Navy	3.5K (TDY)
10 - Equipment Crews	6 Days	Army	None-Unit Training
		(Sub-Totals: A-44K N-38.5K)	

IV - ROLL-ON/ROLL-OFF SHIP DEPLOYMENT EVALUATION:

ITEM	TIME	SVC	ESTIMATED COST
EQUIPMENT			
1 - LCU 1466 Class	3 Days	Army	None-SVC Owned
1 LCU 1644 Class	3 Days	Army	None-SVC Owned
1 - Causeway Ferry	3 Days	Navy	None-SVC Owned
Vehicular Test Cargo (Illustrative)			
1 - Tank, 60 Ton		Army	None-SVC Owned
1 - Road Grader		Army	None-SVC Owned
1 - Aircraft (CH 47)		Army	None-SVC Owned
1 - Dozer D-8		Army	None-SVC Owned
1 - Crane (30 Ton)		Marines	None-SVC Owned
Transportation Cost		Army	10K
1 Ship Marriage Ramp		Army	25K - Transportation & Fabrication
PERSONNEL			
10 - Loading Team	5 Days	Army	None-Unit Training
20 - Equipment Crews	3 Days	Army	None-Unit Training
10 - Equipment Crews	3 Days	Navy	None-Unit Training
		(Sub-Total: A-35K)	

V - CONTAINER HANDLING (PRE-TEST):

ITEM	TIME	SVC	ESTIMATED COST
25 - Forty-foot Containers	14 Days	Army	None-Joint Cost
TO&E Equipment & Personnel of Terminal Service Company			
		(Sub-Total: None)	

VI - MANAGEMENT & CONTROL

ITEM	TIME	SVC	ESTIMATED COST
Spectra-70 W/Remote Terminal	10 Days	Army	10K - Technical Support
		(Sub-Total: A-10K)	

Pre-Test Related Travel & TDY		Army	50K
		Navy	36K
		Marines	10K

PRE-TEST TOTALS:

ARMY - 175K

NAVY - 75K

USMC - 10K

TOTALS 260K

SERVICES
MAIN TEST SUPPORT REQUIREMENTS
TASK ORGANIZATION AND BILL OF MATERIALS

II - MATERIAL AND SERVICE SUPPORT		Services	Estimated Cost
600 MILVANS (20' Containers)		Army	SVC owned 3/
600 Sets MILVAN Exercise Cargo (300 at Ft. Eustis)		Army	SVC fabrication
600 S/T Palletized Exercise Cargo (B.B. Ship) (Requires Refurbishing)		Army	SVC owned
Vehicles for RO/RO Operation-	Tank, 60T	Army	SVC owned
	Road Grader	Army	SVC owned
	Dozer	USMC	SVC owned
	Aircraft	Army	SVC owned
Aircraft for NSDA Loading (Barge Ship)		Army	SVC owned
Lighting Sets for Night Operations		Army	SVC owned
2-Back-up Cranes (1-100T Floating) (1-150T Beach)		Army	SVC owned
Lashing Materials (For NSS Ship, Bargeship and Breakbulk Ship)		Army	SVC owned from pre-test
Communications Equipment for Test Operations-	Test Directors Net	Army/Navy	SVC owned
	Boat Control Net	Army/Navy	SVC owned
	Helicopter Net	Army/Navy	SVC owned
	Container Management Net	Army	SVC owned
	Movement Control Net	Army/USMC	SVC owned
	Evaluator Net	Army/Navy	SVC owned
Beach Preparation Material & Application		Army/USMC	SVC Stocks
2 - Lightweight Spreader Lift Bars		Army	SVC owned

3/ May require relocation of most MILVANS from West Coast. Commercial leasing is alternative to be explored.

II - MATERIAL & SERVICE SUPPORT (CONTINUED)

	Services	Estimated Cost
Recovery Vehicles	Army	
Container Maintenance & Repair Elements	Army	
Exercise Cargo Recoopering Detachment	Army	
Safety Monitors	Army/Navy	10K
Medical Support Detachment	Army	None
Administrative Water-Craft	Army	None
Administrative Vehicles	Army	10K
Visitors Bureau Support	Army	15K
Mess Facilities & Rations	Army	None
POL Storage & Issue Facilities	Army	None

SERVICES
MAIN TEST SUPPORT REQUIREMENTS
TASK ORGANIZATION AND BILL OF MATERIALS

	Estimated No. Personnel	Approximate Days Duration
I - TASK ORGANIZATION		
ARMY-UNITS - Trans Terminal Battalion (Reinf)		
1 Trans Bn Hq & Hq Detachment (-)	30	15
1 Trans Terminal Service Company (Cont)	265	15
1 Trans Terminal Service Company (Conv) (-)	150	15
2 Heavy Boat Plat (-) (8 LCU)	85	15
1 Lighterage Section ACV (Prov) (2 LACV 30)	40	15
1 Med Boat Platoon (4 LCM)	15	15
2 100-Ft Tug Det	12	15
2 BC Barges	--	7
1 Composite Amphibian Det (2 LARC XV, 2 LARC LX)	20	7
1 Trans Term Transfer Plat	85	15
2 Trans Med Trk Plat	100	15
2 Cargo Documentation Teams	20	15
1 Trans Movement Control Det	15	15
1 Marine Maint Det and Recovery Boat	15	15
1 MP Traffic Control Det	16	15
1 Engr Port Constr Det	35	15
1 DSU/GSU Supply Det	50	15
2 CH-54s With Crews & Maintenance Det	20	7
	973	

Estimated Added Annual Cost Increment
For Increased Equip. Operation Cost,
Training, Travel, & Tdy.

ARMY - 260K

I - TASK ORGANIZATION (CONT)

	Estimated No. Personnel	Approximate Days Duration
NAVY UNITS		
1 Amphibious Construction Bn Hq Det	10	10
2 Warping Tugs & Crews (2-Tugs)	10	10
1 Elevated Causeway (4 Sec) Crew	52	10
(Pile Driving Teams)		
(Elevating Teams)		
(Welding Teams)		
1 Self-Propelled Causeway Ferry	10	10
1 Navy Cargo Handling and Port Group Det	25	15
1 Firefighting Crash & Rescue Team w/Rescue Aircraft & Surface Craft	10	5
	117	

Estimated Annual Cost Increment for Increased Equipment Operation, Training, Travel and Tdy.

NAVY - 160K

	Estimated No. Personnel	Approximate Days Duration
MARINE CORPS UNITS		
1 Shore Party Plat (Reinf)	50	10
Det Heavy Equip Plat		
Det Serv Bn & FSR Supply Elms		
1 CH-53E Helicopter with Support Crews	15	5
	65	

Estimated Annual Cost Increment for Equipment Operation Cost, Training, Travel and Tdy.

USMC - 35K

APPENDIX I

POINTS OF CONTACT

A particularly significant aspect of the study approach is the emphasis that has been given to liaison and coordination with the services and other DOD elements having interests and responsibilities relating to LOTS operations. A list of the activities contacted during the course of the study is shown below.

ODDR&E, OSD	HQS, MTMC
OASD (I&L)	HQS, MSC
OJCS – J4	OASA (I&L)
DOD PM (SCSDSD)	HQS, EUCOM*
HQS, SACLANT	HQS, USA TRADOC
HQS, CINCLANT/FLT	NAV FACILITIES COMD
HQS, DA	MOBILITY EQUIP DEV COMD
OPNAV	USMC MCDEC
HQS, USMC	USA LOGISTICS CENTER
HQS, REDCOM*	USA LOGISTICS MGMT CENTER
MSC – EUROPE*	NAV AIR SYS COMD
USA TRANSPORTATION SCHOOL	USA COMPUTER SYS COMD
NAV CIVIL ENGR LAB*	USA OPNL TEST & EVAL AGENCY
HQS, USAF	MARITIME ADMINISTRATION (EMERGENCY PLANS DIR)
AF EASTERN TEST RANGE*	HQS, DEFENSE SUPPLY AGENCY

*CONTACT ONLY

APPENDIX J

GLOSSARY

AFCSS. The Army in the Field Container System Study.

Amphibious Operation. An attack launched from the sea by naval and landing forces embarked in ships or craft, involving a landing on a hostile shore.

ANSI. American National Standards Institute, a non-government organization established by various trades to provide uniformity in the characteristics of consumer goods. The ANSI MH-5 committee was formed in 1958 to establish specifications and the basis for standard size containers for use in the U. S. ANSI provides U. S. representation with the International Organization for Standardization (ISO).

Bargeship. A high speed vessel (20-22.5 knots) designed to load and discharge its unitized cargo without recourse to deep water piers. The ship's cargo is loaded into individual water-tight floating barges which are loaded and documented prior to the ship's arrival. The barges are moved by harbor tugs from a lighter station to the barge carrier and float in sequence into the ship's stern well and are positioned using ship's handling equipment.

Breakbulk Ship. A ship with conventional holds for the stowage of breakbulk cargo, below or above deck, and equipped with cargo handling gear. Ship may also be capable of carrying a limited number of containers above or below deck secured by conventional methods.

Container. An article of transport equipment designed to be transported by various modes of transportation; having an interior volume of four hundred cubic feet or more; designed to facilitate and optimize the carriage of goods by one

or more modes of transportation without intermediate handling of the contents and equipped with features permitting its ready handling and transfer from one mode to another. Containers may be fully enclosed with one or more doors, open top, tank, refrigerated, open rack, gondola, and other designs.

Containerization. The use of containers to unitize cargo for transportation, supply, and storage. Containerization incorporates supply, security, packaging, storage, and transportation into a distribution system from source to user.

Containership. A vessel equipped with racks, rails, or other devices for the stowage of containers. These vessels may be self-sustaining or non-self-sustaining.

DDR&E. Director Defense Research and Engineering.

Developmental Test & Evaluation (DTE). Testing to insure that engineering is reasonably complete, design problems identified, and solutions are at hand.

DODPM. Department of Defense Project Manager (for Surface Container-Supported Distribution Systems Development).

DSA. Defense Supply Agency.

Direct Support System. An Army supply support system designed to provide palletized (air) and containerized (surface) support to overseas general support units and direct support units directly from designated depots or container consolidation points in CONUS, bypassing theater depots and breakbulk points: a required feature of inventory in motion.

Fixed Port Terminal. An established shoreside installation at which passengers and/or cargo are transshipped between oceangoing ships and inland transport equipment.

Intermodal Transport. The capability of interchange of containers among the various mode items of transport.

International Organization for Standardization (ISO). An international body representing over 50 national committees in promoting the development of standards on a worldwide basis. The purpose of ISO is to facilitate international exchange of goods and services and to develop mutual cooperation in the areas of intellectual, scientific, technological, and economic activity. ISO has published standards for dimensions, ratings, and construction of freight containers.

Joint Operational Test & Evaluation (JOTE). Operational tests that involve the use of assets of more than one service.

LARC. Lighter, amphibious resupply cargo. A vehicle specially designed to operate in an amphibious environment. Three models (LARC-V, LARC-XV, and

the LARC-LX) having 5-, 15-, and 60-ton capacities are used for ship-to-shore and river crossings as cargo carriers.

LCM8. Landing craft, mechanized, mark 8. A landing craft with a 60-ton capacity used in ship-to-shore operations.

LCU. Landing craft, utility. A landing craft with a 180-ton capacity used in ship-to-shore operations.

Lighter-Aboard-Ship (LASH). A specially constructed ship in which barges serve as the ship's holds. A self-contained crane loads and offloads the barges, which may be towed between pier and ship by tug. Certain LASH vessels are also equipped with shipboard container cranes and can handle a number of 20-foot containers. The capability can be increased by ship-yard conversion.

LOTS Systems. A generic term used in this report to describe: the organizations, equipment, and operating procedures of the services for the off-shore discharge of cargo from a ship, including their deployment means; transport of cargo from the ship to a location at the beach or inland; unloading of such craft/vehicles; staging and/or trans-shipment of cargo; and the introduction of cargo into the distribution system. The terms "LOTS subsystems","elements", "components" are used to further identify techniques, equipment, and organizations.

LOTS Subsystems. A generic term used in this report to describe three broad sub-categories of a LOTS system -- specifically, ship off-loading, ship-to-shore movement, and shoreside handling. The management and control function is treated as part of the third subsystem (shoreside handling), although it includes activities in all subsystems.

LOTS Subsystem Elements. A generic term used in this report to identify groupings of personnel, equipment, or functions that constitute or are a part of a LOTS subsystem (such as off-loading). Examples of subsystem elements are the temporary container discharge facility (ship off-loading), LACV-30 (ship-to-shore movement), and elevated causeway (shoreside handling).

LOTS Subsystem Components. A generic term used in this report to identify major items of hardware which comprise a subsystem element. For example, the components of the crane-on-deck element (ship off-loading subsystem) are the mobile crane and a hatch cover reinforcing kit. Components of the elevated causeway element (shoreside handling subsystem) are the crane, the causeway, and causeway support equipment.

MAF. Marine Amphibious Force. A task organized force consisting of a Marine division, air wing (or elements thereof), and force troops units, which would employ a LOTS-related operation for the landing of assault follow-on equipment and resupply.

MARAD. Maritime Administration.

Marshalling Area. An area in the vicinity of the beach for holding containers being discharged and awaiting transport inland. In addition, the space may be used for container repacking, container repair, or other operational or administrative functions, including limited distribution of contents. Approximately 12-15 acres are required to marshal each 1,000 containers 20 feet in length, based on single-tier container units.

Materials Handling Equipment (MHE). Mechanical devices for movement of supplies with greater ease and economy.

MILSTAMP. Military standard transportation and movement procedures.

MILVAN. Military Van. An Army-owned intermodal (land-sea) 8'x8'x20' container meeting ANSI/ISO standards.

MSC. Military Sealift Command.

MTMC. Military Traffic Management Command.

Non-self-sustaining Containership. A containership which lacks organic capability for container load/discharge operations.

Operational Test & Evaluation (OTE). Testing to provide a valid estimate of a system's operational effectiveness and suitability when stressed in an operational environment.

OSDOC. Offshore Discharge of Containerships.

Pallet. A flat cargo platform with enough clearance underneath to accommodate a lifting device, i.e., fork tines, spreader, C clamp, etc. Pallets are constructed of wood, metal, plastic, paperfibers, or combinations of these materials.

Roll-on/Roll-off (RO/RO) Ship. A ship designed to carry cargo that can be rolled on and off the ship. The ship can carry breakbulk cargo, containers, or equipment on wheels. Special loading ramps are utilized. These ramps can be located on the bow, on the side, on the stern, or in combination.

SEABEE. SeaBarge. A ship designed to carry barges. It can also serve as a RO/RO ship.

Self-sustaining Containership. A containership constructed with on-board handling gear for container load/discharge operations.

Stripping. A term applied to the unloading of material from a container.

Stuffing/Unstuffing. Terms applied to the loading of cargo into containers and the removal of cargo from containers. The term "stuffing" means the loading of cargo into containers as distinguished from the process of loading containers aboard ship.

Surface Container-Supported Distribution System. A distribution system that uses surface modes and rotary wing aircraft for transport of containers.

Tare Weight. Weight of a shipping container.

TO&E. Tables of organization and equipment.

Transfer Point. A point at which cargo transfers between modes of transportation or between responsible transporting units.

Throughput Distribution. A generic term used to describe shipments which bypass intermediate installations.

Trans-Hydro Craft. Trans-hydro craft are craft that float on the surface of the water; are supported above the surface of the water by an air cushion, foil or other means; or fly over a body of water. They can also possess land mobility. Trans-hydro craft are used by the Army in lighterage operations, coastal and inland waterway operations, harbor service, and other roles in which mobility over bodies of water is required.

Unitization. The consolidation into a single load of quantities of one or many different line items of supply in such a manner that the load can be moved in an unbroken state from source to distributor or user as far forward as practicable.

APPENDIX K

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